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BY B. M. WAGNER, C.E.

[*Read November 11, 1914.*]

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This paper was read by title only. Discussion is invited for publication in subsequent issues of the Journal.

FLAT RATES.

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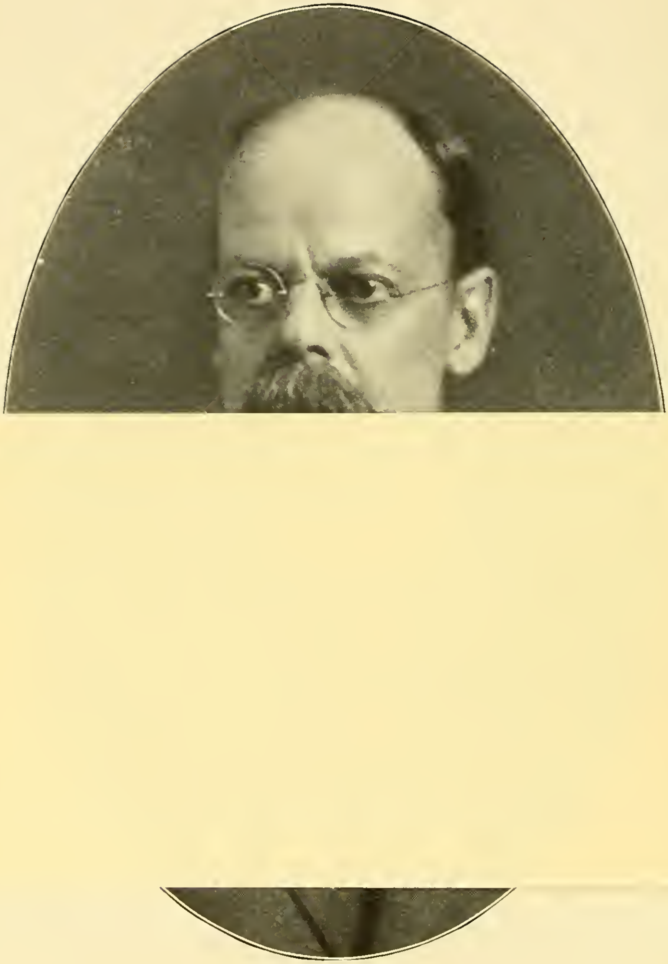

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RATES FOR WATER SUPPLY.

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The writer was given an assignment by his official superior, some time ago, to prepare a digest of what had been done in the matter of fixing water rates, and considered that while the matter he herewith submits presents no new or startling feature, it might be of interest to our members as a review of the subject of water rates, and perhaps bring about a discussion that would clear up some points that seem in dispute at the present time.

So far as can be ascertained, the earliest rates were a matter of guess work, pure and simple, and as new water works were brought into existence their rates were based either on an average of the rates in use, at the time, in other communities, or were, in some cases, made equal to the lowest existing water rates then in use. In general, no attention was paid to cost of service.

Flat Rates.

All of the earlier rates were flat rates, that is, a fixed price per year covered a certain class of service without any regard to the quantity of water used. The details of such flat rates varied somewhat, but they can be divided broadly into the following classes:

(*a*) The main rate is based on frontage of the building along the street or service main, said rate including some fixtures, with certain additional charges for all excess fixtures. New York and

Chicago rates are based on such a system and examples of the rate charged are shown on Table 1.

This is positively the most unscientific method of charging for water, and has no reason for being, except custom.

(*b*) The main rate is based on the number of rooms in the house to be served, in general with a minimum rate covering from one to a fixed number of rooms, and with additional charges covering the use of all fixtures except the kitchen sink. Table 2 gives extracts from the rates of this kind used in St. Louis.

This method is in use in the greater part of the United States, and while not as poor a method as the frontage rate method, has very little to commend it and is, in any case, an inducement to waste water. Table 3 gives average from a compilation made by Mr. D. R. Gwinn, in 1908, of rates used in 375 cities in the United States, and averages given by F. J. Jordan in 1909.

TABLE 1.

EXAMPLES OF FLAT FRONTAGE AND FIXTURE RATES.

NEW YORK CITY — One Family.			
Front Width.	1-Story.	3-Story.	5-Story.
16 ft. or less	\$4.00	\$6.00	\$8.00
16 ft. to 18 ft.	5.00	7.00	9.00
18 ft. to 20 ft.	6.00	8.00	10.00
20 ft. to 22½ ft.	7.00	9.00	11.00
22½ ft. to 25 ft.	8.00	10.00	12.00
	Etc.		
37½ ft. to 50 ft.	14.00	16.00	18.00

CHICAGO — One Family.			
Front Width.	1-Story.	3-Story.	5-Story.
12 ft. or less	\$2.50	\$5.50	\$8.50
12 ft. to 15 ft.	3.50	6.50	9.50
15 ft. to 18 ft.	4.50	7.50	10.50
18 ft. to 21 ft.	6.00	9.00	12.00
21 ft. to 24 ft.	7.00	10.00	13.00
	Etc.		
82 ft. to 87 ft.	20.00	23.00	26.00

Other widths and number of stories in proportion.

New York.	Chicago.
Includes 1 Water closet.	Includes water closets.
1 Bath.	Baths.
Kitchen sink.	Kitchen sinks.
Wash tubs.	Wash tubs.
Wash basins.	Wash basins.
Family not defined.	Family limited to 12 persons.
Additional baths, \$3.00.	Over 12 persons, \$0.50 per person.
Additional water closets, \$2.00.	Additional families, \$7.00 per full set fixtures.
Hose only on meter.	Hose, 30 ft. front or less, \$2.00.
Additional families, \$1.00 plus fixture charges.	Hose, 30 ft. front to 50 ft., \$3.00.
	Steam heating, \$0.05 per ton coal used.

Building Purposes.

New York.		Chicago.
\$0.10	Per 1 000 brick.	\$0.05
.05	Per cu. yd. masonry.	—
—	Per cord stone.	.06
—	Per cu. yd. concrete.	.02
.40	Per 100 sq. yd. plaster.	.15

Samples of Miscellaneous Rates per Year in Addition to Flat Rates.

New York.		Chicago.
\$5.00	Barber shop, 3 chairs.	—
1.00	Barber shop, additional chair.	—
—	Barber shop, bath tub.	\$6.00
3.00	Bakery, per oven.	—
—	Bakery, per barrel flour.	.01
—	Wash basins.	2.50
2.00	Water closet.	3.50
—	Urinal.	1.50
—	Laundry tubs.	1.75
5.00 up	Dining saloons.	1.00 per table.
5.00	Retail fish stands.	1.50
1.00	Stables, per stall.	1.00 to 2.00.
—	Stables, hose.	3.00
8.00 up	Laundries.	—
10.00 up	Liquor saloons.	2.00 per bar, 2 faucets.
—	Liquor saloons, additional faucets.	1.00
—	Liquor saloons, hydraulic pump.	3.00
5.00	Photo galleries.	10.00
5.00 up	Soda fountains.	3.00 up.

New York.		Chicago.
10.00 per h.p.	Steam boilers up to 10 h.p.	4.00 per 10-hr. day.
7.50 per h.p. over 10 h.p.	Steam boilers 10 to 15 h.p.	4.00 per 10-hr. day.
5.00 per h.p. over 15 h.p.	Steam boilers 15 h.p. up.	4.00 per 10-hr. day.
5.00 to 10.00	Florists.	—
7.50	Milk depots.	3.00 up to 16-gal. limit.
10.00	Bottling establishment.	10.00

Meters.

In New York the Commissioner has the right to order a meter placed in any place where water is furnished for business consumption. Expense of meter and setting of same is on the consumer. Meter rate, 10 cents per 100 cu. ft.

In Chicago every building where the net assessment under frontage and fixture rates equals $100 or more per annum must be metered. City supplies and sets meters at its own expense. Meter rates, 62½ cents per 1 000 cu. ft., less 10 cents per 1 000 deduction if the bill is paid within 30 days.

TABLE 2.

FLAT RATE ON ROOM BASIS, ST. LOUIS, MO.

1 to 3 rooms	$2.00 per year.	Includes kitchen sink only.
4 to 5 rooms	3.00 per year.	
Each additional room	1.00 per room per year.	
Tenement rooms	1.00 per year each.	
Private baths	2.00 per year each.	
Private water closets	3.00 per year each.	
Beds, lodging house	.50 per year each.	
Public baths	15.00 per year each.	
Public water closets	10.00 per year each.	
Public urinal	20.00 per year each.	
Churches	10.00 per year each.	
Club rooms	20.00 per year each.	
Schools	.05 per scholar.	
Halls	5.00 per year.	
Horses and mules	3.00 per year each.	
Cows	1.00 per year each.	
Vehicles	2.00 per year each.	
Stable, hose	5.00 per year.	
Livery, hose	50.00 per year.	
Dairy, hose	20.00 per year.	
Stables, per stall	2.00 per year.	

Stores	10.00 per year.
Shops and offices	5.00 per year.
Barber shop, one chair	5.00 per year.
Barber shop, two chairs	7.00 per year.
Barber shop, three chairs	9.00 per year, etc.
Candy and ice-cream saloon	15.00 per year.
Restaurants	20.00 per year.
Saloons	20.00 per year.
Lunch rooms	15.00 per year.
Photo galleries	20.00 per year.
Washing bottles	25.00 per year.
Bakeries	10.00 per year.
Laundries	20.00 per year.
Soda-water fountains	50.00 per year.

Meter rates and regulations not available.

The fixture and business rates are in addition to regular flat rates based on rooms.

TABLE 3.

Average Water Rates Compiled by D. R. Gwynn in 1908 — 375 Cities, United States.

	Per Annum.
6-room house (includes only kitchen sink)	$6.40
Bath tub	3.40
Water closet	3.38
Wash basin	1.74
Hose (lot, 50 x 140)	5.20
Total	$20.12
Meter rate, maximum per 1 000 gal	$0.262
Meter rate, minimum per 1 000 gal	.092

Another Average Given for United States. F. J. Jordan. (1909.)

	Per Annum.
6-room house (water in kitchen only)	$6.28
Bath, water closet, basin and wash tubs	7.21
Hose for 40-ft. frontage	4.94
Total	$18.43
Meter rate, maximum per 1 000 gal	$0.22
Meter rate, minimum per 1 000 gal	.09

Hydrant Rentals. F. J. Jordan. (1909.)

	Per Annum.
Average for United States	$47.00
Minimum for United States	8.00
Maximum for United States	79.00

Hydrant Rentals. Mr. Sawyer. (1903.)

	Per Annum.
Average for United States	$49.43

Hydrant Rentals. Metcalf, Kuichling, and Hawley. (1911.)

	Per Year.
Average, 22 cities (Eastern states)	$29.38
Average, 73 cities (Central and S. W. states)	45.03
Average, 24 cities (Southern states)	42.54
Average, 6 cities (Western states)	28.42
Average, 125 cities	$41.05

(*c*) A flat minimum rate, based on the size of tap supplying the premises, with charges covering all fixtures.

This method is used in Philadelphia, and extracts from the Philadelphia rates are given in Table 4. This seems a more logical method, although many causes exist that would prevent it from being a just and equitable tax in every instance.

TABLE 4.

Flat Rates on Fixture Basis.

Philadelphia provides a charge for each fixture with a minimum charge per each size tap. Fixtures are charged for as follows:

	Each.
Kitchen sink	$5.00
Bath tubs	3.00
Basins, slop sinks	1.00
Water closets, siphon flush	5.00
Urinal siphon flush	5.00
Wash tubs (2 tubs)	1.00
Hose privilege	5.00
Dwellinghouses without hydrant or sink on premises,	$5.00
Building, 1 000 brick	.05
Building, perch stone	.02

Samples of Additions to Dwelling Charges for Business Purposes.

	Per Year.
Bakeries	$3.00
Barber shops	3.00
Bars	20.00
Baths	6.00
Photographers, per operator	5.00
Boilers, per h.p.	2.00
Milk houses	5.00
Heating boilers	5.00
Fish stalls, each	5.00

Minimum Rates per Tap.

½ in.	$5.00
⅝ in.	16.00
¾ in.	26.00
1 in.	40.00
1¼ in.	62.50
1½ in.	90.00
2 in.	160.00
3 in.	360.00
4 in.	640.00
6 in.	1 440.00

Minimum Meter Rates.

⅝ in.	$8.00
½ in.	5.00
¾ in.	13.00
1 in.	20.00
1¼ in.	31.25
1½ in.	45.00
2 in.	80.00
3 in.	180.00
4 in.	320.00
6 in.	720.00

Meter charge, 30 cents per 1 000 cu. ft.

Meters are property of city. No rental charged. Consumers liable for damages exclusive of wear and tear, or fire. Director of Public Works has power to meter any place where city water is used. Charitable institutions pay 4½ cents per 1 000 cu. ft. of water used.

(*d*) A flat rate method that is not in use but has certain advantages over those previously mentioned would be along the lines of a rate proportional to floor space supplied.

Mr. W. W. Brush, Deputy Chief Engineer of Water Supply, New York City, made certain investigations in various classes of buildings throughout that city and found a remarkable uniformity of water consumption based on floor area, and if a flat rate is used it would seem a more equitable proposition to charge for water based on actual floor areas supplied rather than on a frontage alone.

In all places where flat rates are in use provision is made either for optional or compulsory metering of the water used by certain classes of consumers.

Meter Rates.

The tendency of the present day is more and more towards metering of all services, and is based on the logical idea that each consumer should be obliged to pay only for the water actually used or for service rendered, irrespective of whether the saving in consumption of water is or is not sufficient to justify the expenditure for meter service.

However, the mere fact that all services are metered does not guarantee a fair deal to all consumers, as in some cases the meter rates are nearly as inequitable as the flat rates would be.

At present the following classes of meter rates are in use:

(*a*) The fixed rate; that is, a fixed price per 100 cu. ft., or per 1 000 gal., with no limit as to amount of water used or not used.

This method is generally in use where the consumer pays for the furnishing and installing of the meter. In this connection it may be of interest to know that in Wisconsin the Railroad Commission in 1909 gave a decision that a city has no right to compel a consumer to either rent or purchase a meter, much less a meter of any particular make or type. At San Diego, Cal., on the other hand, the consumer pays the city a fixed sum for the installation of each size of meter and service. This payment not only covers cost of installation, but also perpetual maintenance.

The trouble with a fixed rate is, that unless it is unduly high the water works are not apt to be on a paying basis. Take, for instance, a flat rate of 10 cents per 1 000 gal. The water used by an ordinary family of five persons would be about 3 000 gal. per month, or, at the above rate, $3.60 per year, which would hardly

be a paying proposition for a water works. To avoid this contingency a minimum charge is sometimes provided for, covering all water used up to a certain fixed amount.

(*b*) A sliding scale where the small consumer pays the maximum rate and the price is graded inversely to the amount of water used.

While not an equitable arrangement, this form of rate has been extensively used, and is defended by its advocates on the grounds of general business practice as between retail and wholesale consumers. In this system of rates, as in (*a*), the consumer either owns and pays for the meter, or the cost of same must be covered by the rates charged. The weak point of this form of rates may be illustrated by the experience of Springfield, Mass., in 1910. Meter rates ranged from a maximum of 25 cents per 1 000 gal. for small consumers, to a minimum of 6 cents for the largest consumers, while the actual cost of furnishing the water was $9\frac{1}{2}$ cents per 1 000 gal.

(*c*) A fixed charge per annum for each size of service, covering readiness to serve with a certain amount of water included, and a fixed or sliding rate per 1 000 gal. consumed over and above the amounts allowed in the fixed charge.

(*d*) A fixed charge per annum for each size of service that covers, simply, "readiness to serve," all water used being paid for at a fixed rate per 1 000 gal. or per 100 cu. ft.

This last is the form of rate that is considered by most experts and the various commissions as being the logical, equitable, and scientific form of rate.

In the form of rates considered under (*c*) and (*d*) the fixed charge is taken as covering certain fixed expenses and charges that exist whether water is used or not, the difference being that in the form considered under (*c*) the fixed charge is made large enough to cover the furnishing of a certain amount of water. Its advocates claim for it that it discourages any tendency to undue restriction of the use of water with consequent unsanitary conditions.

Table 5 gives examples of various forms of meter rates.

TABLE 5.

Showing Examples of Meter Rates.

New Britain, Conn.:

Minimum charge, $6.00 per year, includes 5 000 cu. ft.

5 000 to	100 000 cu. ft. per year at	$0.12 per 100 cu. ft.
100 000 to	300 000 cu. ft. per year at	.10 per 100 cu. ft.
300 000 to	600 000 cu. ft. per year at	.08 per 100 cu. ft.
600 000 to	1 000 000 cu. ft. per year at	.06 per 100 cu. ft.
1 000 000 or over	cu. ft. per year at	.05 per 100 cu. ft.

Sliding Scale, Frankfort, N. Y.:

Minimum charge, $7.00 per year.

First	25 000 gallons	$0.28 per 1 000 gallons.
Next	10 000 gallons	.24 per 1 000 gallons.
Next	15 000 gallons	.21 per 1 000 gallons.
Next	15 000 gallons	.18 per 1 000 gallons.
Next	20 000 gallons	.15 per 1 000 gallons.
Next	20 000 gallons	.13 per 1 000 gallons.
Next	110 000 gallons	.12 per 1 000 gallons.
Next	275 000 gallons	.11 per 1 000 gallons.
Next	500 000 gallons	.10 per 1 000 gallons.
Over	8 000 000 gallons	.05 per 1 000 gallons.

Sliding Scale, Cleveland, Ohio:

Minimum charge per year (?).

If use 2 000 cu. ft. or less	$1.212 per 1 000 cu. ft.
If use 3 000 cu. ft. to 5 000	0.571 per 1 000 cu. ft.
If use 6 000 cu. ft. to 50 000	0.404 per 1 000 cu. ft.
If use 50 000 cu. ft. (suburban special),	0.425 per 1 000 cu. ft.

Fixed Charge and Sliding Scale, Madison, Wis.:

5/8-in. meter	$3.00 per year.
3/4-in. meter	3.50 per year.
1-in. meter	4.00 per year.
1 1/2-in. meter	5.50 per year.
2-in. meter	7.50 per year.
3-in. meter	12.00 per year.
4-in. meter	20.00 per year.

If more than one consumer on one meter, one dollar per consumer (extra).

Water rate:

$0.06 per 100 cu. ft. up to 150 000 cu. ft. per year.
.05 per 100 cu. ft. over 150 000 cu. ft. per year.

Ready to Serve and Straight Scale, New Orleans, La.:

Meter.	Per Year. 1912.	Per Year. 1913.
$\frac{5}{8}$ in.	$4.00	$3.00
$\frac{3}{4}$ in.	5.00	3.60
1 in.	6.60	4.80
$1\frac{1}{2}$ in.	10.60	7.20
2 in.	14.50	12.00
3 in.	22.00	18.00
4 in.	36.00	24.00
6 in.	64.00	42.00
8 in.	97.00	72.00

All water 7 cents per 1 000 gal.

Sliding Scale, Wallingford, Conn.:

First	15 000 cu. ft.	$1.50 per 1 000 cu. ft.
Next	10 000 cu. ft.	1.25 per 1 000 cu. ft.
Next	15 000 cu. ft.	1.00 per 1 000 cu. ft.
Next	20 000 cu. ft.	.90 per 1 000 cu. ft.
Next	40 000 cu. ft.	.85 per 1 000 cu. ft.
Next	100 000 cu. ft.	.75 per 1 000 cu. ft.
Next	100 000 cu. ft.	.65 per 1 000 cu. ft.
Over	1 050 000 cu. ft.	.25 per 1 000 cu. ft.

Louisville, Ky. — Proposed Fixed Charge for Service and Fixed Rate:

$\frac{5}{8}$-in. meter	$6.00 per year.
$\frac{3}{4}$-in. meter	9.00 per year.
1-in. meter	12.00 per year.
2-in. meter	24.00 per year.
6-in. meter	72.00 per year.

Catasauqua, Pa. — Readiness to Serve and Fixed Charge:

$\frac{5}{8}$-in. meter	$0.50 per month.
$\frac{3}{4}$-in. meter	1.00 per month.
1-in. meter	1.50 per month.
$1\frac{1}{2}$-in. meter	2.00 per month.
2-in. meter	3.00 per month.
3-in. meter	4.00 per month.
4-in. meter	8.50 per month.
6-in. meter	10.00 per month.

San Diego, Cal.:

City owns meters, makes a fixed charge covering the installation of service meter and meter box. This charge covers perpetual maintenance of the installation and replacement of same in all cases when damaged and not due to direct action of consumer.

Size of Meter.	Cost of Meter and Box.	Cost of Service.	Cost of Paving.	Total Cost of Installation.
$\frac{5}{8}$ in.	$8.00	$10.00	$17.00	$35.00
$\frac{3}{4}$ in.	14.00	10.00	17.00	41.00
1 in.	20.00	12.00	20.00	52.00
$1\frac{1}{2}$ in.	37.00	20.00	21.00	78.00
2 in.	67.00	32.00	22.00	121.00
3 in.	137.00	100.00	24.00	261.00
4 in.	250.00	126.00	26.00	402.00
6 in.	500.00	166.00	30.00	696.00

All water used, charged for, 8 cents per 100 cu. ft.

The Fixing of Rates by Municipalities or States for Water-Supply Systems.

The earlier water-supply franchise in the United States either ignored the question of rates entirely, or fixed an arbitrary maximum schedule based on existing rates in near-by municipalities. In some few cases the franchise provided for a readjustment of the rates at the end of certain fixed periods. In California the State constitution prescribes that all municipalities must, yearly, by ordinance, fix the water rates that may be charged by private water corporations operating within the municipal limits. This right was called into question by the Contra Water Company which supplies the city of Oakland with water, in a case of rate fixing, and the decision given in the United States Supreme Court in 1911 states, among other things:

"That the provision of a state constitution for fixing rates annually for the use of water is sustained, on the ground that where one devotes property to public use he grants the public an interest therein and must submit to being controlled for the common good." The opinion goes on to state that the fixing of rates is a legislative and not a judicial function, and that the legislature has a right to delegate this function to some minor body, and that when a city ordinance fixing rates for a corporation supplying water is enacted in the manner prescribed by law, it cannot be set aside unless it is invalid on the constitutional ground of being confiscatory in depriving the corporation of property without due process of law.

The burden of proof resting in that case with the corporation that claims the rates are confiscatory.

The opinion states that the rates fixed must be ample to cover the following items:

(*a*) Operating expenses.

(*b*) Taxes.

(*c*) Current repairs.

(*d*) Annual depreciation of property.

(*e*) A fair return on the fair value of the property. (For what constitutes a fair return, see Table 6.)

No allowance is to be made for past depreciation, and in getting at the value of the property the corporation is not entitled to any allowance for goodwill.

That rate-making is a legislative function and may be delegated by the legislature to some subordinate or administrative body, is also covered in the United States Supreme Court decision in the Knoxville case.

In general, the courts have held that in all cases where the franchise or charter, under which a water company operates, does not distinctly specify the rates that may be charged or method of fixing the same, the right to regulate the rates rests with the legislatures and, in all cases where the matter is in doubt, the benefit of the doubt is to be taken as in favor of the public and against the private corporation.

Where rates are fixed by the franchise they cannot be diminished by the legislature, but in such cases, even where a corporation has a contract or franchise providing that no contract or privilege will be granted to any other person or corporation to furnish water to a certain city, the United States Supreme Court decided that, in the absence of a special stipulation to that effect, the city is not precluded from establishing its own independent system of water works. See 200 U. S., page 22, Knoxville.

Wilcox, in his work on franchise, advocates the taxation to death of any corporation that cannot be otherwise reached in case of unjust rates, but this method appears to be unnecessary, inasmuch as the people affected can, always, by legislative enactment, condemn and purchase the property of the offending corporation by due process of law. " Eminent domain

is superior to franchise rights. Franchise is merely property." See decisions 166 U. S., page 693; 115 U. S., page 673.

Within the last few years a great many states have placed all matters affecting public utilities, including water works, under the jurisdiction of special public-service commissions. According to the publication of the National Civic Federation, at the end of 1912, the following states had such commissions that included among their functions the regulation of water-works corporations: Arizona, California, Maryland, Nevada, New Hampshire, Ohio, Rhode Island, South Carolina, Virginia, Washington, Wisconsin, New Jersey.

In New York the State Conservation Commission, under Chapter 647 of the Laws of 1911, passes on water-supply matters.

In Massachusetts the State Board of Health covers all water-works matters.

During 1913 measures were taken in the following states either to create Public Service commissions, or to extend the jurisdiction of existing commissions so as to cover water-works matters: Colorado, Delaware, Illinois, Maine, Kansas; and during the same period the following states made changes in the existing commissions so as to give them jurisdiction in water supply matters: Idaho, Indiana, Oklahoma, Missouri, Montana, West Virginia, North Carolina, Ohio.

These commissions, with trifling exceptions, are all modeled on either the California or Wisconsin commission plan. Such variations as exist are of a minor character, and are best shown by a few examples.

Ohio excludes any value, due to franchise or merger, from consideration in rate making.

Wisconsin and Oregon provide that depreciation must be considered in fixing rates.

South Carolina provides that rates may be varied according to value of service rendered.

Before going further it may be well to give an outline of the Wisconsin and California Utility Laws, as these two may be considered the models on which the commissions of other states have been formed.

Wisconsin Public Utility Law.

Section 1797. —

M–1. Defines public utility as including every corporation, company, individual, and every town, village, or city, that now or hereafter may operate, etc., any plant for the production, transmission, delivery, or furnishing of heat, light, power, or water, either directly or indirectly to the public.

M–2. Gives the Railroad Commission of Wisconsin the right to supervise, regulate, etc., the above-defined utilities.

M–3. Provides that reasonable service must be furnished and reasonable charges made.

M–5. The Commission is given direction to value all property of public utilities.

M–8. Uniform accounts must be kept and submitted to the Commission.

M–9. Commission given the power to prescribe all forms, books, etc.

M–15. A proper depreciation account must be provided by each corporation, and the Commission has the power to determine and fix such rates of depreciation. The Commission is to provide for such depreciation in fixing tolls or rates.

Monies so provided and set aside to be carried in a special fund, and may be used either for new construction, extension, or additions; or may be invested, in which case the income from such investment is to be carried in the same depreciation fund.

M–27. All rate schedules must be filed with the Commission. No rate can be charged without consent of the Commission. No preference or favor may be shown to any one, in either rate or its collection. Penalties are attached to both taker and giver in the violations of the above rules.

M–43. Provides for hearing of complaints, etc. A municipality must appear before the Commission, and is subject to the same rules as a private corporation. Citizens have the same rights as to complaints against a municipality as against a private corporation.

M–74. Provides against competition where a utility is in operation under an indeterminate Commission permit. This applies

also to municipalities. The Commission may, after a public hearing, decide competition is necessary.

M–76. Provides that licenses, permits, or franchises granted by the Commission shall be practically indeterminate franchises.

M–87. Gives municipal councils the power to determine, by contract or ordinance, the quality and character of each kind of product or service to be furnished by a public utility inside the municipal limits, together with all terms and conditions not inconsistent with the terms of the Public Utility Law. They can also order such additions or extensions as are reasonable and necessary. All of the above powers of municipalities are subject to the review and approval of the Commission.

M–88. Provides that no passes or free service of any kind is to be given to any public official or any other person.

California Public Utilities Act.

A constitutional amendment on December 23, 1911, gave the California Railroad Commission certain powers over all public utilities. These powers are, in brief, as follows:

(*a*) Power to fix all rates, charges, and classifications.

(*b* to *n*) Relate to railroad matters only.

(*o*) Power to fix standards, classifications, measurements, and practices of all gas, electric, and water corporations.

(*p*) Power to ascertain the value of the property of every public utility.

(*r*) Power to permit or to refuse to a public-utility corporation the right to enter a field already served by a like corporation.

(*s*) Power to permit or to refuse to permit a corporation to exercise rights under new franchises or permits.

(*t*) Power to regulate transfers of property used in public service, including the acquisition by one public utility corporation of stock in any other such corporation.

(*u*) Power to regulate and control all issues of bonds, stocks, or other evidences of indebtedness within the state.

Hearings are heard without regard to the technical rules of evidence so as to get at the truth as quickly and simply as possible.

A party aggrieved by the decision of the Commission must apply

for a rehearing and give reasons for the same; and if a rehearing is refused, can appeal to the State Supreme Court for a review of the question on the evidence presented at the hearing of the Commission without any new evidence, and the findings of the Commission as to questions of fact will be considered final.

Ample provision is made for bonds to be filed by petitioners for review so as to protect those who would be injured by delay if the decision finally given is in their favor, and for impounding excess rates, etc., at interest until questions of validity are settled.

All of these provisions are drawn in such a manner as to prevent long-drawn-out legal proceedings and foolish appeals.

It is provided that all existing rights of cities and towns to fix rates, etc., are continued in form under the new law, but the Act provides that any city or town can hold an election and, on vote in favor, can turn control of all its public utilities over to the Railroad Commission.

An amendment to the Act excludes the Railroad Commission from the control of municipally owned utilities, and restricts its jurisdiction to private corporations.

Existing privileges of private corporations are exempted from Commission control, but as such companies cannot extend their operations except as allowed by the Commission, a large measure of control is possible even for these companies.

General Rules that Seem to Govern Courts and Commissions in the Fixing of Water Rates.

(1) No unmeasured water is to be supplied for any purpose.

Water supplied to public buildings, institutions, etc., to be metered.

Water for sprinkling to be measured or estimated as closely as possible.

Water for fire purposes to be based on hydrant rental. (Method of getting at hydrant rental will be considered later on.)

All of the water used for above purposes, whether supplied to a municipality by a private corporation, or by its own works, is to be paid for by direct taxation, and should not in any case be made part of the water rate paid by individual consumers.

(2) All water rates should be so figured as to provide for the following factors:

(*a*) A fair return on the fair value of the plant.

(*b*) All proper operating costs.

(*c*) An allowance for current repairs and renewals, and for taxes, if any.

(*d*) A yearly increment to provide a so-called depreciation fund.

(3) A fixed or minimum charge is to be made that will cover all overhead or capacity charges, and this minimum charge is to apply not only to individual consumers, but also to those portions of the supplies that are used for public purposes.

(4) A fixed charge for actual amount of water used, based on the actual cost of supplying the same. This charge is usually given as so much per 1 000 gal., or per 100 cu. ft.

While the general trend of opinion is to the effect that no variation should be made in the price so fixed, the practice in some localities still sanctions the use of a sliding scale with reductions in price for what may be called wholesale consumers.

(5) A hydrant rental based on the extra cost of plant, etc., required to furnish fire protection over and above what would be required to provide for ordinary consumption.

The above general principles seem to be universally admitted as correct, but in the application of them there are bound to be differences of opinions and of methods used. Before taking up the matters involved in these differences, a short summary of the methods used in Madison, Wis., and those used in New Orleans, La., are given as examples for comparison.

MADISON, WIS.

Value of the plant was fixed by the Commission, based on inventory checked by books and reports.

Value adopted, $576 188.

Interest allowed on investment, 4 per cent., as this was a municipal plant; for private plants, the Commission allows 6 per cent.

Depreciation allowance (assumed), $3 500 per annum.

Taxes allowance (assumed), $5 000 per annum.

Operating expenses were made up from averages of expenses, etc., for past years.

Coal, assumed as $11 900 per annum. (Actual for 1909, $7 891.)

Maintenance of buildings, $500 per annum. (Actual for 1909, $850.)

Maintenance of reservoirs, etc., $165 per annum.

1909.

Operating expenses	$31 184.33
Interest	23 047.52
Taxes	5 000.00
Depreciation	3 500.00
Total	$62 731.85

The Commission makes a sharp distinction between the expenses of operation, due to the capacity of the plant, and those due to actual output. The first, or capacity-expense class, is fairly constant, but the output expense naturally varies with the amount of water used. Some items partake in part of the nature of each class, and all accounts are tabulated and distributed, in a table which gives a distribution of expense made some time after the rates, established by the Commission, had been put in service.

The original determination gave the capacity charge as 49.93 per cent. of the total, which makes a nearly even distribution of expense into the two classes for this particular case. Ordinarily, it has been found that capacity charges amount to from 60 to 70 per cent. of the whole.

Capacity expenses are further divided into public and private service charges. The various items were divided, according to the judgment of the engineers, as follows:

	Public.	Private.
Reservoirs and standpipes	$18 769	$6 256
Distribution mains	144 189	187 452

The summation of all the capacity items showed a distribution of 49.6 per cent. for public and 50.4 per cent. for private service.

Output expenses were based on amounts of water used, 254 795 608 gal. being charged to private consumption, and 182 523 000 gal. to public consumption.

From the figures so obtained, the Commission determined charges or cost, as follows:

> Capacity cost, $31 506.96; output cost, $30 752.67.
> City should pay, $28 906.96.
> Private consumers should pay $33 352.57.

The city actually had paid $1 675 interest on bonds and an allowance of $10 000 for taxes (not paid).

On the basis above outlined the rates were fixed and divided into two parts, viz., service charge based on capacity charge, outlined as follows:

$$\text{Capacity charge} = \begin{cases}\text{Readiness to serve.}\\ \text{Meter charge.}\end{cases}$$

$$\text{Meter charge} = \begin{cases}\text{Maintenance} = \begin{cases}\text{Interest.}\\ \text{Depreciation.}\\ \text{Maintaining meter.}\end{cases}\\ \text{Reading meter.}\end{cases}$$

Capacity Account Part of Meter Maintenance Cost.

Meter cost was $50 000.00.	
Interest and depreciation taken as 8 per cent	$4 000.00
Capacity charge taken as 70 per cent. of meter maintenance cost	490.00
Meter reading cost per year	508.75
Total	$4 998.75

The total capacity charge for private consumers was found to be $15 454.62. Deducting the meter charge, $4 998.75, leaves $10 457.87 as the sum that the private consumers should pay irrespective of whether water is used or not.

The meter charge of $4 998.75 was divided among the meter users as follows:

Reading 4 418 meters, $508.75, or $11\frac{1}{2}$ cents per meter. The balance of meter charge was distributed according to size and cost of meter used, and gave $94\frac{1}{2}$ cents for a $\frac{5}{8}$-in. meter. The total net capacity charge divided among 5 723 consumers gives $1.82 per year, two dollars being taken as the nearest even amount.

The schedule adopted was as follows:

Size of Meter. Inches.	Per Half Year.
$\frac{5}{8}$	\$1.50
$\frac{3}{4}$	1.75
1	2.00
$1\frac{1}{2}$	2.75
2	3.75
3	6.00
4	10.00

When more than one consumer is served from the same meter an addition of one dollar for each such consumer is added to the fixed meter charge.

The equitable charge to consumers, figured on their part of the output expense, should be $5\frac{1}{4}$ cents per 100 cu. ft., but the actual charge was fixed at 6 cents per 100 cu. ft. Resulting rates gave only a slight reduction to consumers.

TABLE 6.

SHOWING OPINIONS ON WHAT CONSTITUTES A FAIR RATE OF RETURN.

Iowa Supreme Court, 1902, Water Company case, 4.4 to 5.5 per cent. is not confiscatory.

U. S. Circuit Court, 1903, Spring Valley Water Co., Cal., 5 per cent. is the minimum rate.

U. S. Circuit Court, 1904, Contra Water Co., Cal., 5 per cent. is the minimum rate.

Maine Supreme Court, 1904, Water Co. case, reasonable rate of return depends on circumstances.

N. J. Chancery Court, 1905, Water Co. case, 5 per cent. is the minimum rate.

U. S. District Court, California, Water Co. case, 5 per cent. is a reasonable return.

U. S. Supreme Court, Knoxville, Water Co. case, undecided whether 4 per cent. is confiscatory.

N. Y. Court of Appeals, 1909, Jamaica Water Co., 6 per cent. is a fair return.

U. S. Circuit Court, 1909, Water Co. case, 6 per cent. is a reasonable rate.

U. S. District Court, 1911, Spring Valley Water Co:, 3.97 per cent. is confiscatory.

U. S. Circuit Court, 1911, Des Moines Water Supply Co., 8 per cent. is a fair return.

Wisconsin Commission allows 6 per cent. for private plants and 4 per cent. for municipal plants.

NEW ORLEANS, LA.

From article by George W. Earle in 1911, and from yearly report New Orleans, for 1912:

The general rules adopted were that all taps were to be metered, even for the so-called free services.

All free water to be eliminated, and the general Tax Fund was budgeted in such a manner as to apportion to each department the value of the water it used.

The department keeps accounts, makes collections, reads meters, taps water mains, makes connection to and sets meter without a direct charge.

All of the above is provided for from the meter "service charge."

The cost of the water service is distributed as follows:

(1) Fair hydrant rental.

(2) Fair service charge for each size meter and connection.

(3) Fair price per 1 000 gal. of water used.

(4) Fair amount raised by direct taxation to cover so-called "free water."

Cost of works, $8 500 000.

Cost of meters and connections, $750 000.

Cost of works, less meters, $7 250 000. This cost is apportioned as 25 per cent. to fire service and 75 per cent. for all other uses.

Population, 340 000; plant capacity, 45 000 000 gal.

Miles of mains, 515; maximum filter capacity, 67 000 000 gal.

Hydrants, 5 000; pumping capacity, 100 000 000 gal.

Distribution system capacity, 80 000 000 gal.

Daily consumption was assured as follows:

Private consumers	8 400 000 gal.	Includes under registration.
Public and charity	3 600 000 gal.	
Fire Dept. and Public Works hydrants	2 000 000 gal.	
Leakage and sewer flushing	2 000 000 gal.	

(1) Interest and depreciation, $4\frac{1}{2}$ per cent. of $5 810 000	=	$261 000.00
(2) Interest and depreciation (Fire Service), $4\frac{1}{2}$ per cent. of $1 940 000	=	87 000.00
(3) Interest, depreciation, and maintenance meters	=	60 000.00
(4) Meter reading, collection, and accounting	=	40 000.00
(5) Maintenance costs distribution system	=	50 000 00
(6) Maintenance costs fire hydrants	=	10 000.00
(7) Maintenance and operation of pumping plant	=	150 000.00
Total		$658 000.00

Item 7 charge, \$70 000 to output and \$80 000 to capacity.

Charge for fire hydrants includes all of items 2 and 6, one fourth of item 5, one seventh of output portion of item 7, and one fourth of capacity portion of item 7, making a total of \$139 500 for 5 000 hydrants, or \$28 per hydrant. This is a per capita charge of \$0.41 for fire protection.

Meter service charge includes items 3 and 4; it is provided pro rata according to number and size of meters. Three tenths of the total, or \$30 000, is charged to public consumers, and the remaining \$70 000 is charged to private consumers. To results so obtained further fixed items are added.

The service charges for the various meters range from \$4 for a $\frac{5}{8}$-in. meter up to \$97 for an 8-in. meter.

The total cost of water used is made up of all of item 1, three fourths of item 5, twelve fourteenths of the output portion of item 7, and three fourths of the capacity portion of item 7, and amounts to \$418 500. This is apportioned 30 per cent. to public and 70 per cent. to private consumers.

The total distribution of expense is taken as follows:

	Fire. Hydrants.	Service. Charge.	Water. Charge.	Total.
Direct from taxpayers..........	\$139 500	\$30 000	\$125 550	\$295 050
Direct from rate payers........		70 000	292 950	362 950
Totals....................	\$139 500	\$100 000	\$418 500	\$658 000

The 1912 report of New Orleans states that the water rate was 7 per cent. per 100 cu. ft. to all consumers, and that it has been found possible to make reductions in the service charges for all sizes of meters, as follows:

Size of Meter. Inches.	Service Charge, 1912. Per Annum.	Service Charge (Proposed). 1913.
$\frac{5}{8}$	\$4.00	\$3.00
$\frac{3}{4}$	5.00	3.60
1	6.60	4.80
$1\frac{1}{2}$	10.60	7.20
2	14.50	12.00
3	22.00	18.00
4	36.00	24.00
6	64.00	42.00
8	97.00	72.00

The actual amount of water used during 1912 for public purposes was as follows:

Schools, public buildings, etc.	392 000 000 gal.
Sewer flushing	30 000 000 gal.

This was charged at $6\frac{2}{3}$ cents per 1 000 gal.

Service rates on the above, $3 200.

Fire hydrants, 5 098, at $35; $78 430.

The total amount charged to direct taxation was $214 060, as compared with the $295 050 estimated in 1911.

Value of and Proper Charge for Fire-Hydrant Rental.

In 1903 an article by J. T. Sawyer gave the average fire-hydrant rental for the United States as $49.43, giving as his authority the Manual American Water Works for 1888.

Mr. Sawyer made up a yearly cost per hydrant for small four towns ranging from 1 000 to 35 000 population on the basis of the difference in cost between a water-supply system for domestic use only and for a combined domestic and fire service. Three-inch was the minimum size main allowed for strictly domestic service system, and six-inch for a combined fire and domestic service. Table No. 7 shows how the costs were arrived at.

TABLE 7.

Showing Sawyer's Comparison of Costs between Domestic versus Combined Fire and Domestic Water Supply Systems. (1903.)

	Population in 20 Yrs.	Miles Mains.	No. of Hydrants.	Hydrants.		Kind of System.	Total Cost.
				Per 1 000 Population.	Per Mile of Main.		
Tolono	1 000	2.74	21	21	7.7	D	$12 847.52
						D & F	25 766.89
Paxton	6 000	7.72	57	95	7.4	D	32 733.47
						D & F	58 698.91
Danville	23 000	22.23	160	69	7.2	D	60 924.65
						D & F	131 417.44
Springfield	35 000	33.77	255	73	13.3		
						D & F	383 818.59

TABLE 7 — (*Continued*).

	Excess Initial Cost per Hydrant.	Yearly Interest at 6 Per Cent.	Additional Yearly Cost per Hydrant.			Fire Protection. Yearly Cost.	
			Operation.	Sinking Fund.	Total.	Per Mile of Main.	Per Hydrant.
Tolono.....	$615.21	$36.91	$9.64	$12.31	$58.86	$451.09	$1 236.06
Paxton.....	454.83	27.28	12.74	6.47	46.49	343.26	441.65
Danville...	440.00	26.40	14.09	8.42	48.91	352.03	340.28
Springfield .	598.38	35.90	7.12	7.21	50.23	319.87	379.30

NOTE. — D = Domestic. D & F = Domestic and fire.

Mr. C. C. Brown, in commenting on the article, states that the average annual cost of furnishing fire service is about 50 per cent. of the annual fixed charges on plant, plus 20 per cent. of the actual operating expenses. The figures arrived at by Mr. Sawyer practically agree with this theory.

In 1908 Mr. D. R. Gwinn published some figures on fire-hydrant rentals without going into the matter of how same were fixed.

In 1911 Messrs. Metcalf, Kuichling, and Hawley, in the American Water Works Association, took up the question of fire-hydrant rentals in detail, and called attention to the fact that, up to that time, practically all hydrant rentals were based on the averages of the existing rates in nearby communities, or, in large cities the rental was fixed by using the existing rentals in the nearest city of about the same size. In some places the hydrant rentals were fixed to take care of the interest charges upon the necessary investment, and all other charges and profits were supposed to be derived from the regular water rates.

As to the hydrant rentals actually paid, the following figures from the last-mentioned article will serve as examples:

Average hydrant rental,	22 cities (Eastern states)	$29.38 per annum.
Average hydrant rental,	73 cities (Cent'l and S. W. states)	45.03 per annum.
Average hydrant rental,	24 cities (Southern states)	42.54 per annum.
Average hydrant rental,	6 cities (Western states)	28.42 per annum.
Average hydrant rental,	125 cities	41.05 per annum.

A certain company that supplies a number of municipalities in the Middle West had a schedule made up as follows:

Contract Time, Years.	Annual Charge for Fire Protection. Per Mile of Main per Year.	Additional per Hydrant per Year.
1	$325	$15
10	275	6
20	260	5

It is to be noted that this is a combination charge.

Another common method of paying for hydrant service is a fixed annual rental per hydrant coupled with a clause that the Water Company must furnish one additional hydrant for each 600 ft. or so of new distribution pipe laid. This method is not as equitable as would be a provision that the city shall pay a lump sum per year for fire protection and have the right to attach as many hydrants as it wants to, to the mains, upon payment of a rental per hydrant, based on the actual cost of hydrants and connections. Provision for increased rental in this case to be based either on a pro rata to the increase of population, or in proportion to distribution main mileage in the district covered.

If, however, the payment is to be based only on hydrant rental, the rational method of arriving at a proper individual hydrant rental would be to determine what percentage of the total cost of the water-supply system was made necessary in order to provide for fire protection, and add to the interest and depreciation charges figured therefrom that portion of the operating expenses that is due to the use and maintenance of the hydrants, and divide the cost so found by the number of hydrants in use.

Such hydrant rentals should be determined, if possible, at intervals of a few years, for it is evident that the hydrant rental so arrived at will not be a correct measure of the cost for very long if the municipality is a growing one.

The authors of the paper last mentioned seem, however, to be of the opinion that the rental paid should be somewhere between the cost of the service to the water company and the value to the community of the protection afforded it.

The total costs for hydrant rental should, in any event, be assessed on the community as a general tax and not be put on individual consumers in the form of an increased rate.

The actual percentage of the cost of water supply systems, chargeable to fire protection, will naturally vary owing to a

variety of causes, and the following extracts from Bulletin No. 148, U. S. Geological Survey, give averages arrived at from a list of 1 500 plants.

COST OF FIRE PROTECTION.

Cities, Population.	Cost per Capita.	Total Cost Water Supply of System.	Percentage Chargeable to Fire Protection. Per Cent.

NOTE.

Insert page 27, Vol. 29.

Metcalf, Kuichling and Hawley state (Proc. Am. W. W. Association, 115, 1911), the cost of the portion of the water-works plant involved by fire hydrant service probably constitutes the following percentages of the entire cost of the physical property:

Population less than 5 000................	60 to 80 per cent.
Population 100 000, more or less..........	20 to 30 per cent.
Population of our largest cities............	10 to 20 per cent.

In fixing the value of the fire-hydrant rental for New Orleans, the cost of the part of the system properly chargeable to fire protection was formerly taken as being about 33.4 per cent. of the whole cost. In 1911 the cost of fire service was taken as 25 per cent. of entire cost, less cost of meters.

The above authors give a number of interesting formulæ bearing on percentages of cost of fire service, but to my mind all such formulæ are of very limited application and cannot take the place of actual observed and computed results. Along the lines of the formulæ mentioned may be considered the statement that the yearly cost of public fire-hydrant service is to be taken as $1.00 per capita, with a variation of 40 per cent. either way.

* Proc., Am. W. W. Association, 1911.

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1	$325	$15
10	275	6
20	260	5

It is to be noted that this is a combination charge.

[illegible] method of paying for hydrant service is a [illegible]

cost so found by the number of hydrants [illegible]

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variety of causes, and the following extracts from Bulletin No. 148, U. S. Geological Survey, give averages arrived at from a list of 1 500 plants.

COST OF FIRE PROTECTION.

Cities, Population.	Cost per Capita.	Total Cost Water Supply of System.	Percentage Chargeable to Fire Protection. Per Cent.
All plants	$27.21	$1 129 247 532	21.75
100 000 or over	32.72	591 222 244	15
30 000 to 100 000	29.06	184 803 174	23
5 000 to 30 000	23.60	235 718 456	32
Under 5 000	16.59	117 503 268	65

The Wisconsin Railroad Commission, in determination of rates for Appleton, stated that from 40 to 50 per cent. of the entire plant cost was chargeable to fire protection. In Ashland (population, 11 594), 54½ per cent. of the capacity cost is charged to the city for water used for public buildings, institutions, etc., and for fire service.

Figures given by Metcalf, Kuichling, and Hawley* would make the percentage of entire plant cost due to fire protection service as follows:

Population, 5 000	60 to 80 per cent.
Population over 5 000, under 100 000	20 to 30 per cent.
Population over 100 000	10 to 20 per cent.

In fixing the value of the fire-hydrant rental for New Orleans, the cost of the part of the system properly chargeable to fire protection was formerly taken as being about 33.4 per cent. of the whole cost. In 1911 the cost of fire service was taken as 25 per cent. of entire cost, less cost of meters.

The above authors give a number of interesting formulæ bearing on percentages of cost of fire service, but to my mind all such formulæ are of very limited application and cannot take the place of actual observed and computed results. Along the lines of the formulæ mentioned may be considered the statement that the yearly cost of public fire-hydrant service is to be taken as $1.00 per capita, with a variation of 40 per cent. either way.

* Proc., Am. W. W. Association, 1911.

To my mind the proper form of fire-hydrant rental would be a certain lump sum per year, entirely independent of the number of fire hydrants in use, plus a fixed sum per hydrant, both of these figures to be revised at intervals of not more than five years and to be based as far as possible on average figures for that term.

The lump sum to be based on the interest, depreciation, and maintenance charges of that percentage of the plant that is chargeable to fire protection (exclusive of cost of hydrants and connections) plus the percentage of operating cost that is due to water used for flushing, fire, or other purpose through the hydrants.

The individual charge per hydrant is to be made up of the interest, depreciation, repair, and other maintenance charges, based on the cost of the hydrants and connections at the time the rental was being determined; the pro-rata cost per hydrant, thus arrived at, to be held for all additional hydrants ordered placed during the predetermined period.

The cost of private fire protection is, as a rule, not considered, as any plant large enough to take care of the public fire-hydrant service is ample for all such private service, and in most cases the cost of installation and maintenance of the private fire service is carried by the parties utilizing such service. The water used for fire purposes will be approximately the same whether it is used through the public hydrants or the private installations.

Mr. W. E. Miller, in an article on the question of charging for private fire service in Milwaukee, Wis., *Engineering News*, 1913, states that no basis exists for charging for this class of service, except what might be advocated on the basis of value received by the private owner.

As the installation of a sprinkler system is a heavy expense, and its use makes for a decreased amount of water used in putting out fires, in Mr. Miller's opinion it is only fair that no extra charge should be made, especially as the metering of the service precludes any possibility of water being stolen for private purposes.

Rates for Private Fire Protection Service.

The amount and form of rates vary, so that no tabulation can be made, and such published rates as could be found are briefly described, as follows:

Selena, Ala. (Municipal Plant). Forty-five dollars per private hydrant; ten cents a unit per first 100 sprinkler heads, and five cents a unit for each additional sprinkler head, all per year; minimum charge, $100 per year; sealed fire connections with $5 fine each time seal is broken except in case of fire.

Atlanta, Ga. Consumer pays for the expense of all installations, including valves, meters, testing, etc., work being done by city employees.

Rome, Ga. (Municipal Plant). No charge.

Kankakee, Ill. (Private Plant). A minimum charge of $300 per annum; consumer can use water up to amount of charge at the rate of 1 000 gal. per 10 cents.

Terra Haute, Ind. (Private Plant). Meter set at expense of consumer; minimum rates, $20 to $25 per month, whether used for fire protection or not.

Davenport, Ia. (Municipal Plant). Conditions the same as at Terra Haute. A gate valve placed on connection branch, close to main.

Lexington, Ky. No fire service over 2-in.

Battle Creek, Mich. (Municipal Plant).

Size of Connection. Inches.	Yearly Charge.
8	$400
6	200
4	100
3	75
2	50
1½	35
1	20

For more than one connection of the same size on the same premises, one half of the fixed charge is added for each additional connection.

St. Paul, Minn., where fire services are not metered, charges are as follows:

	Size of Connection. Inches.	Yearly Charge.
Two or less	4	$100
Each additional	4	50
Two or less	6	150
Each additional	6	75
For each	8	300
For each	10	1 000
For each	12	1 000

Meters may be ordered placed at the discretion of the water board.

Hackensack, N. J., will provide a meter with full-sized by-pass, gate on by-pass sealed, and to be opened only in case of fire, or will provide a connection without meter; sealed gate of fire connection is independent of regular supply; charge to be one half of minimum water rate for size of pipe used.

Elmira, N. Y.

Size Fire Service. Inches.	Water Allowed to be Used per Year. Gallons.	Total Cost of Service.
6	1 000 000	$75
4	750 000	50
3	475 000	35
2	400 000	25

The rates given are in addition to regular charges for water used for general purposes.

Jamestown, N. Y. (*Municipal Plant*). Free service, consumer pays cost of connection.

Erie, Pa. (*Municipal Plant*). One connection furnished to curb; size limit, 6 in.; may be used for fire service only; no charge.

Richmond, Va. Charge, $50 per year for each fire protection system; consumer agrees to use water through the fire connection for fire purposes only.

San Diego, Cal. Consumers for regular service pay a fixed sum that covers the cost of installing service pipe, meter box, meter, etc., with perpetual maintenance of the same, and where the service is used for sprinkler fire service only a proportional meter may be used in place of the standard type meter. Reductions in cost are made as follows:

	Regular Type.	Fire Service.
2-in. service and meter, complete,	$121	$94
3-in. service and meter, complete,	261	184
4-in. service and meter, complete,	402	232
6-in. service and meter, complete,	696	296

Meters are required on fire services at the following places: Worcester, Mass.; Hartford, Conn.; Belmont, Mass.; Bridgeport, Conn.

At New Haven, Conn., the right to meter is reserved.

At Milwaukee, Wis., no charge is made for fire services, but cost of connection and meter is paid by consumer.

Valuation for Rate-Making.

The valuation of a water-works property may be made for four different purposes, and need not be the same for any two of these purposes. They are as follows:

(1) Taxation.

(2) Accounting and capitalization.

(3) Public purchase.

(4) Rate making.

The first two are of no concern to us, and what little information is available on (3) has in most cases been evolved from data and experience acquired in working out valuation for rate making.

Some confusion exists as to what is meant by " value," which term is often confounded with cost. The actual cost of a thing is not necessarily a criterion of its value, and such actual cost would probably be the same for all purposes and, at the same time, not its value for any of the purposes for which a valuation was to be made.

The leading case from which most of the present data on rates has been developed was that of Smyth *v.* Ames, in 1898 (U. S. 18 Sup. Ct. 418, 42 Led. 819, March 7, 1898). The United States Supreme Court therein clearly decided " that a fair return on the fair value of the property used for the convenience of the public was the chief basis for the determination of the reasonableness and the constitutionality of a rate." Since that time various courts and commissions have ruled that specific elements of a valuation may vary with the purpose for which such valuation is made.

U. S. District Judge Farrington, in the Spring Valley Water Co. case, 165 Fed. 667–696, October 7, 1908, ruled that value for taxation is not admitted as evidence of value for rate purposes. The United States Supreme Court ruled that value fixed for taxation was not material in fixing on value for rates (Wilcox *v.* Consolidated Gas Co.).

The Wisconsin Railroad Commission has ruled the same way.

The Indiana Railroad Commission takes the same position.

Mr. Whitten, in his book, "Valuation for Rate Making, etc.," states that the fundamental distinction between valuation for taxation or accounting on the one hand and for rate making or condemnation on the other hand, is that the first group is subject to legislative control, as no constitutional rights are involved, but that valuation for either rates or forced purchase is subject to review by the United States Supreme Court.

The question arises, "What is a fair value for rate making?" The answer is not easy to find in any case. Judge Farrington, of the U. S. Supreme Court, in a decision on rates, states, in substance, as follows:

(1) The cost of reproduction is not a fair measure of value unless a proper allowance is made for depreciation. All parts of a plant are subject to wear or decay.

(2) The original cost is not in all cases a fair criterion of value. The plant may have cost too much or not have been properly adapted for the purpose intended. It may be too large.

If an increase in value of any part has taken place, the corporation is entitled to a fair return on such increased value, provided such return does not mean an unjust or unreasonable charge to the public.

(3) The aggregate market value of stocks and bonds is not, as a rule, a reliable index of fair value of the plant, as such market values are too often simply the result of manipulations.

Other judicial opinions are to the same effect.

In general, the courts and commissions have refused to commit themselves as to what constitutes a fair value for rate making, and have adopted as a leading factor one of the following standards, and used the others as a sort of test or check on the value so desired:

(1) Actual cost method.
(2) French method.
(3) Market value method.
(4) Cost of reproduction method.

The following actual rate cases give an idea of the process used by the Wisconsin Commission.

Hill *v.* Antigo Water Co., August 3, 1909, 3 W. R. C., R. 623:

Cost of reproduction, new, plus bond discount	$102 860
Above, less depreciation	95 077
Earning value on a 6 per cent. basis (market value)	95 282
Earning value on a 4 per cent. basis (market value)	119 464
Going concern value addition	7 000 to 10 000
Allowed commission valuation	110 000

Ontario City Water Supply Co., August 7, 1911:

Cost reproduction, new	$126 648
Cost reproduction, less depreciation	116 547
Actual investment	139 400
Allowed commission valuation	125 000

ACTUAL COST METHOD.

The preliminary report of the Special Committee on Valuation of Public Utilities of the American Society of Civil Engineers favors the cost of Reproduction Method for old properties, but also favors providing by law "that future public service properties should be valued on the basis of their actual reasonable investment; all additions and replacements to original plant to be added to such original valuation, and all amounts allowed for depreciation to be deducted."

Mr. Whitten states that where Actual Cost Method is used, it should be original cost, plus all additions and betterments, inclusive of renewals and replacements. Where reference is made in court decisions to actual cost, they have, in many cases, loosely interpreted the term so as to include such items as discount on securities issued, profits to promoters, cost of replacements, dividends paid out of capital, etc.

Mr. Whitten considers actual cost, when properly determined, as the fairest method of valuation for rate purposes, but admits that it is very hard, and in some cases impossible, to determine it.

The Interstate Commerce Commission, in 1911, accepted actual cost as a basis for rates.

Connecticut Public Utilities rejected this method in 1912.

FRENCH METHOD.

A method of arriving at the fair value of a plant that has been used in some Wisconsin cases, and by the French and Swiss governments in taking over railroad systems, and which might be used

for first valuation rate cases where a proper accounting system has been in use from inception of the plant considered, is described by Bion J. Arnold in an article on Valuation of Street Railroads in Kansas City, as follows:

Find each year the actual investment in property, deduct the value of superseded property in the year it was superseded, and estimate a fair return on this net investment.

Deduct from such return the net income after paying all operating expenses, including maintenance, renewals, and taxes, charging to operation, however, the cost of superseded property in the year when superseded.

Then compound each year the deficit or surplus, as the case may be, between the fair return and net income. The result will show a sum representing the accrued loss estimated upon the basis of a return at a given rate per cent.

The total of the accrued loss, plus the actual investment, will be the fair value of the entire property, or, in case an excess or total accrued gain is shown, it should be deducted from the amount of the actual investment for a fair value of the property.

MARKET VALUE METHOD.

The market value theory recognizes the fact that a business must be valued as a single unit, and that such a business is worth what a responsible bidder will offer. The appraisal on this basis is merely an estimate of the amount that normally would be offered in open market. Mr. Whitten states that reasonable rates cannot be based on market value, as such market value is based on rates, and it would be a case of reasoning in a circle. While market value is not, and cannot be, a standard for rate making, it finds its use occasionally in the valuation of a misplaced or partially obsolete plant.

Judge Brewer, 154 U. S. 362–14, Sup. Ct. 1047, 38 L. ad 1014, May 26, 1894, says: " Equal protection of laws and the spirit of common justice forbids that any one class should be compelled to suffer loss so that others may make a gain."

The report of the special committee of the Am. Soc. C. E. is not favorable to the use of the market value standard, but admits that it was formerly largely used.

COST OF REPRODUCTION STANDARD.

The first question that arises under this method is whether the valuation shall be on the basis of actual duplication of the existing plant, or on the basis of a plant of modern design that will be capable of producing the same results as the plant to be valued.

The Am. Soc. C. E. special committee advocates the identical plant method and gives the following grounds for its view:

(*a*) General weight of court decisions favor this method, but no actual decision.

(*b*) Eliminates personal element in deciding what would constitute a proper substitute.

(*c*) Past allowances for depreciation have generally not been large enough to make it just to use substitution method.

(*d*) Adoption of substitute theory would greatly increase depreciation charges to be met in early stages of plant development.

Mr. Whitten states that the cost of reproduction does not necessarily mean cost of exact duplication.

The courts in several cases have ruled that the cost of reproduction can be used as for a plant of similar character and efficiency. In many cases it is impossible to provide an exact duplication, and, to my mind, the decisions of the courts do not intend a rigid adherence to exact duplication, but give latitude for such substitution as may be made necessary by types of plant parts that could not be duplicated in open market at the time of valuation.

The next question is that of costs. Should present prices and conditions be used, or should the prices and conditions obtained at the time the plant was constructed be used?

Mr. Whitten favors actual physical conditions at the time the plant was built, but does not commit himself as to prices.

The Am. Soc. C. E. special committee favors using original physical conditions, but the prices to be those ruling at the time the valuation is made, and quote a number of instances to support their view. On the other hand, in some recent rate cases where valuation of mains laid originally in streets not paved was involved, the present period condition was allowed for in fixing the valuation. (See Wilcox *v.* Consolidated Gas Company.) In general, it seems

to me that present prices and conditions should rule as the fair value of a plant, for rate making is not what it would have cost in the past, but what it is worth or would cost now.

The other points that arise in the matter of physical valuation are:

(1) Valuation of land.
(2) Invested surplus.
(3) Unused property.
(4) Excessive investments.
(5) Average or actual price.
(6) Overhead charges.
(7) Discount on bonds.
(8) Working capital.
(9) Piecemeal or unit construction.
(10) Physical depreciation.
(11) Depreciation of overhead charges.
(12) Functional depreciation.

The question in all the above points is, What allowance, if any, is to be made for the same, and how is it to be arrived at?

(1) *Valuation of Land.* The few cases decided that take up this matter vary, and the courts are not all agreed as to just what value should be taken. In the Consolidated Gas Company case, 212 U. S. 19–52–29, Sup. Ct. 192, 53. Led. 352, January 4, 1909, the present value of the land was taken. The Am. Soc. C. E. special committee appears to favor original cost in some cases.

To my mind, the stand taken by Alton D. Adams in his article on valuation of water works, *Municipal Journal*, June 20, 1912, is the most logical one. He calls attention to the fact that often the increased value of land occupied by pumping stations, etc., which is due to increase in value of residential or business property in the vicinity, could only be realized by the loss of and by removal of the buildings and machinery now on the land in question, and he favors only such land value allowance as would equal the cost of acquiring property having the same utility value for the plant purpose as that which is now in use.

Here again each individual case must be judged on its own merits.

(2) *Invested Surplus.* The Pennsylvania Supreme Court decided in some water company cases that the corporations were entitled to a fair return on all additions built out of surplus earnings.

The Maine Supreme Court decided that the owner is entitled to present value of his plant.

(3) *Unused Property.* The Wisconsin Commission excludes from valuation all property that has been superseded, but excepts from this ruling such property as is retained for emergency or reserve purposes.

United States District Judge Farrington ruled, in a San Francisco water-rate case (1911), that "only that property is to be considered which was then used and useful in supplying water."

Other decisions of the United States Supreme Court are to the same effect.

The special committee of the Am. Soc. C. E., while in general agreeing that the court decisions are wise and just, feels that in certain cases it would be poor policy to enforce this view in cases where a wise provision had been made in parts of a plant for reasons of ultimate economy or to provide for a probable growth in the near future. Where matters of land and water rights are involved, they consider that, if excluded from valuation when first bought, they should enter into the valuation when put into use, not at purchase price, but at the value at which they have arrived at the time of using.

A. D. Adams, in his paper on valuation, expresses the opinion that the following property should not be considered in a valuation:

(*a*) Equipment of such a nature that no one would think of duplicating, such as discarded early types of pumping engines.

(*b*) Equipment that has been superseded by better or larger equipment, as, for instance, an intake and pipe in a supply from the Great Lakes was discarded, even though in proper condition, by reason of a larger intake and pipe that had been put into service.

(*c*) Abandoned parts of plant or sources of supply, as, for instance, a group of artesian wells that cost a large sum were not valued because, though still owned by the water company, their use had been abandoned for a better source of supply.

(4) *Excessive Investments.* This item is practically covered by what has been said under the head of unused property. In special cases allowance may be made for possible immediate growth and consequent requirements.

The United States Supreme Court in the San Diego case decided against allowances for such parts of plant as they considered larger than were required.

The New Jersey Chancery Court in the Long Branch case made a large deduction from plant valuation on the same grounds.

(5) *Average or Actual Price.* Most of the commissions, instead

of taking prices of material and labor that prevail at the time of valuation, use an average of such prices for periods of from 5 to 10 years. In general, the Am. Soc. C. E. special committee's report agrees with this practice.

(6) *Overhead Charges.* Under this head are included:

(*a*) Promotion expenses.

(*b*) Engineering and superintendence.

(*c*) Contractor's profit.

(*d*) Interest during construction period.

(*e*) Legal and incorporation expenses.

(*f*) Taxes.

(*g*) Insurance.

No fixed rule governs the allowances made for the above items. The various commissions have allowed anywhere from nothing to 12 per cent. of the physical valuation to cover such items, interest being not included in the amounts so given as it is generally considered by itself.

The special Am. Soc. C. E. committee gives some figures in connection with the overhead charge items showing percentages actually expended for some of the charges included under this general heading, and advises the use of the actual original figures wherever possible, as local conditions and difficulties affect the allowable percentage to such an extent as to preclude a fixed rule relative to what is a proper allowance. They favor allowing interest from inception of work to time of actually going into service at the interest rate prevailing at the time of valuation.

(7) *Discount on Bonds.* The Wisconsin Commission has made an allowance for this item in some cases but has not made it a rule to do so.

No authority for such allowance exists in any court decision.

(8) *Working Capital.* This includes all expenditures for stores, supplies on hand, and a sufficient fund to bridge the gap between outlay and reimbursement in the early stages of operation. This item is generally allowed for in all valuations.

(9) *Piecemeal or Unit Construction* is a factor only when the valuation is based on actual construction cost and, as such, affects in that case only the unit prices.

(10) *Physical Depreciation.* In the whole subject of valuation

there has not been one single factor that has been the subject of as much discussion and disagreement as the matter of physical depreciation, not so much on that factor itself as on how its extent and effect on general valuation shall be determined. The methods in most general use are as follows:

(*a*) Sinking Fund Method.
(*b*) Straight Line Method.
(*c*) Equal Payment Method.
(*d*) Actual Appraisal Method.

Before taking up these methods in detail it may be well to go into the matter of depreciation itself.

Physical depreciation, for rate purposes, is the lessened utility value caused by physical deterioration or by lack of adaption to function.

As the operation of a public utility is a continuous enterprise, it is the right of the consumers to demand that the annual charges attributable to investment shall be as uniform as possible. These charges include repairs, removals, and replacements needed to keep the plant in good working order. In other words, the allowance for these items should, if possible, be uniform, and in any case should be ample to keep the plant at one hundred per cent. efficiency and to provide for complete replacement of actual capital invested.

The utility value of a plant is dependent on the work that it can perform during its remaining life plus its scrap value, if any. Depreciation, while it is based on deterioration, is, nevertheless, not the same thing. A rail worn fifty per cent. is deteriorated fifty per cent., but the depreciation is much greater. The special committee of the Am. Soc. C. E. has expressed itself on this subject as follows:

"Depreciation is not a lessening of worth for rate-making purposes if the property is kept up to one hundred per cent. efficiency, although it is recognized that there is a lessening of worth for the purposes of sale."

"The yearly amount which the corporation is entitled to earn from the rate payers for depreciation is, with exceptions, the sum necessary for replacing items of property that have become worn out or obsolete, and it is commonly stated that the yearly depreciation is an operating expense."

"The water-works engineer dealing with long-lived properties which infrequently require replacements, but come to the end of their lives through inadequacy or obsolescence, recognizes that the allowance for depreciation, if equivalent only to the cost of replacements from year to year, would be wholly inadequate; that is, the total amount received in the first twenty or thirty years would be very insignificant compared with the lessening of worth of the original items of the property."

The United States Supreme Court in the Contra water case provides for both a depreciation fund and an allowance for yearly replacements or repairs in its decision.

Provision for depreciation is mandatory for rate making in the following two State Commissions:

Oregon — "Must provide for in fixing rates."

Wisconsin — "Shall provide for in fixing rates."

In general it may be stated that wherever depreciation is allowed for in fixing rates, no provision is made for past years, and the yearly allowance made is based on the remaining life of the property at the time of fixing the rate.

Sinking Fund Method. This method assumes that an amount is set aside each year, and invested so that at the end of the life of the property covered it will, with compound interest, represent the cost of the said property.

The depreciation at any time is said to be equal to the amount that is or should be in a fund so accumulated.

This method will, in every case, give less depreciation than by the Straight Line Method.

The Wisconsin Commission has stated that, while there is no actual connection between the rate of depreciation and the rate at which money can be accumulated in a sinking fund, it is reasonable to assume that the four per cent. sinking fund curve fairly represents the progress of depreciation under average conditions.

In the uniform system of accounts for water-supply corporations which was adopted in conference by the following bodies: American Water Works Association, New England Water Works Association, U. S. Bureau of Census, American Association of Uniform Public Accounting, Ohio Bureau of Public Accounting, — it was stated that while it was impossible to frame concise general rules for making depreciation allowances, they would

recommend that physical examinations and appraisals should be made at intervals not exceeding ten years, so as to provide a basis for an estimate of the annual loss chargeable to depreciation. In the absence of and pending the obtaining of this data it will be assumed that the depreciation takes place according to the average life of the parts of a water-supply system and of the life of the system as a whole. They assume, as such, life for —

Horses, carriages, automobiles, and laboratory apparatus and appliances, ten years.

Office furniture and general operating equipment, fifteen years.

Boilers, steampipes, and filtration equipment, twenty years.

Engines, pumpimg machinery, and wooden pipes, twenty-five years.

Masonry of filtration plants, cribs, cast-iron water pipes, intakes and connections, fire hyrants, standpipes and buildings, fifty years.

Reservoirs, tunnels, and aqueducts, one hundred years.

Water supply system as a whole, fifty years.

Current depreciation of the system as a whole is approximately two per cent. of its total original cost.

In the absence of more definite data, the life of the various parts, as above given, can be used for the Sinking Fund Method as well as for the Straight Line Method.

Straight Line Method. This method assumes that the wearing value decreases uniformly each year during the entire life.

For a life of ten years, one tenth of the value represents the depreciation for each year. This method is largely used in purchase appraisals and has the merit of simplicity; it is particularly simple when what is known as the "fifty per cent. method" can be applied.

This is used where a plant or system has been built up in a piecemeal fashion; all parts being, after a cycle or two, fairly evenly distributed as to age, the appraiser can use the fifty per cent. Straight Line Method without involving much error. The method, however, is more applicable to railroad than to water-system valuation.

Equal Payment Method. This method is advocated in the preliminary report of the Special Committee on Valuation for Rate Making of the Am. Soc. C. E., and is simply an adaptation

of what is generally known as the Sinking Fund Method. The committee admits this in its definition of its method, which is a combination of the depreciation charge with the return on investment so as to form a uniform yearly charge to cover both items.

To illustrate, take an item of $100 to cover original cost of a part having a life of twenty years. By the Sinking Fund Method the annual depreciation allowance at 5 per cent. would be $3.02; the annual interest on the original investment at 5 per cent. would be $5.00; total yearly allowance for interest and depreciation, $8.02.

By the Committee Method the depreciation during the first year is $3.02, which leaves a depreciated value of $96.98 at the end of the first year, and a charge of $8.02 for interest and depreciation. At the end of the second year the depreciation is $3.18, and the interest on the $96.98 value at 5 per cent. would be $4.84, making a total of $8.02, as before, for interest and depreciation. However, where the allowed return on capital invested is figured at a greater percentage than is allowed in the depreciation fund earnings, the yearly payment will be a gradually diminishing one.

Actual Appraisal Method. This method is the one that was commonly used prior to scientific investigations of the subject, and is still made use of as a check on the results obtained by the other methods.

Of all the methods described, it would seem to the writer that for the valuation of an old plant being appraised the first time for rate-making purposes, the most logical would be the Direct Appraisal Method, the only drawback being that the personal equation of the appraiser must needs be a factor to be reckoned with.

In these days it would not be hard to arrive at a proper cost of reproduction of the plant with elements very nearly approximating in age and wearing value those in use, and by comparison with the cost of a new plant determine the accrued depreciation.

The so-called Sinking Fund Method applies more particularly to the fixing of the annual depreciation allowance that must be provided for by the rates to be charged. The method proposed by the Am. Soc. C. E. committee gives, in effect, the same re-

sults as the Sinking Fund Method, but as it combines with the depreciation an element that is not necessarily allied to it, i. e., interest on investment, I do not consider it of any especial value.

(11) *Depreciation of Overhead Charges.* In general, this item is not allowed for. The Washington Commission in the Seattle case stated " that depreciation affects only property that wears out, becomes obsolete or inadequate, and requires replacement, and indirect items are therefore excluded from annual charges." In the valuation itself they are considered as having 100 per cent. value. The Wisconsin Commission depreciates overhead charges with the property.

The N. Y. Public Service Commission, 1st District, disallows depreciation on interest and taxes during construction, but allows all other overhead charges to be depreciated with the property.

Many of the overhead charges do not have to be repeated as the various parts and structures are replaced, but those that do have to be repeated, such as engineering and contingent charges of that sort, should be depreciated.

(12) *Functional Depreciation.* This item covers lack of adaptation to function or the replacing of structures, etc., that have become poorly adapted to their work. Supersession or the replacement of structures that have become inadequate before being worn out can be foreseen and provided for by a reserve fund made up as part of and from the operation expenses charges. In these cases the capital cost cannot be charged with both the new item and the one it supersedes. In valuation for rate purposes, or public purchase, all actually accrued functional depreciation should be deducted from cost, new.

In arriving at the valuation of a plant for purchase, all recent opinions seem to indicate that depreciation must be taken into consideration, while in valuation for rate fixing no fixed rule has been arrived at. The Wisconsin Commission, in its earlier cases, used the cost of reproduction, new, but since 1909 has used cost of reproduction less depreciation. Various other commissions and boards have given decisions, some in favor of the first, and others in favor of the second of these methods. The general trend in recent years, however, has been in favor of cost of reproduction less depreciation.

Going Concern Value. As a rule no allowance is made for this factor in rate making. As the value of a business, as a going concern, is based on its income, which in turn depends on its rates, it can readily be seen that this factor cannot properly enter into the subject of rate making. A few decisions are quoted merely to show that even in this matter no uniformity exists.

Cedar Rapids, Ia., Water Company — Going concern value not allowed.

Urbana, Ohio — Fourteen per cent. allowed for going concern value.

Knoxville case — U. S. Supreme Court expressly states that it expresses no opinion on the subject.

Des Moines, Ia. — Ten per cent. allowed for going concern value.

Oakland, Cal., 1911 — Going concern value not allowed.

Wisconsin Commission, both for rates and purchase, holds that certain costs of development during the first years of a plant's existence may be added to the cost of the physical plant and form a going concern value. To my mind they are simply giving another name to what has heretofore been described as overhead charges.

Franchise Value. Very few rate cases have given any support to the theory that a franchise should be capitalized, and included in the value upon which the rates are based.

In two California cases, — Spring Valley, 1903, and Stanislaus, 1911, rate cases, — the franchise value received theoretic recognition, but no franchise value was actually included in the valuation.

The Wisconsin Commission ruled in the Antigo case that no franchise value was to be allowed other than the amounts the company actually paid to the municipality for its franchise.

General Conclusions. In making up water rates the following items must be allowed for:

(1) Interest and profit on the fair valuation of plant.

(2) Taxes.

(3) Operating expenses.

(4) Repairs and minor renewals.

(5) Depreciation allowance, physical and functional.

The fair value of a plant, whether Original Cost or Reproduction Method is used, must be lessened by the depreciation that is due

to the elapsed life of the plant parts. This depreciation allowance must be taken to cover both physical and functional depreciation. In getting at this fair value in a first appraisal for rate making, the main and only concern of both the public and the appraiser is, what is the plant worth now, and not what part of it represents capital actually invested, and what was paid for by past earnings of the plant. If part of the past earnings were reinvested by the owners in making additions or extensions, they are entitled to the values so created; if, on the other hand, they used up all the earnings in dividends, part of their investment has been returned to them and they cannot expect the public to allow them for past depreciation in the new rates.

As to future depreciation allowances they should, in all cases, be carried as a separate account, and if part or all of this money is invested, as for extensions and additions, it must be considered both as new capital invested and, at the same time, be considered as so much old capital repaid. With a proper system of accounting it will be an easy matter to make a revaluation every five years and, in a decade or two, the proper allowance for depreciation will be arrived at. To my mind the term "depreciation" is a misnomer, and this allowance should more properly be called amortization fund and be kept separate from the allowance made for repairs and minor renewals. This last allowance should be ample to keep the plant at one hundred per cent. efficiency.

The yearly depreciation allowance, pending the tabulation of actual data, should be based on the Sinking Fund Method, using as the total life of the parts the figures given on page 41. The fund so accumulated should be used in the case of a municipality to retire the bonded indebtedness and consequent valuation of the plant. For a private plant it may be used as its owners see fit, provided, however, that the account of same is kept as before outlined.

No free water of any kind should be furnished. All water used for charitable or public purposes to be charged for at the uniform rate, and all such supplies to be metered or otherwise properly measured, and the cost of such water to be provided for by general taxation.

The cost of water used for fire purposes and the yearly expenses

of that portion of the plant that is made necessary to supply same must be determined and also provided for by general taxation.

All supplies should be metered and a fixed charge to be made for readiness to serve with a uniform charge per 1 000 gal. or 100 cu. ft., as the case may be.

The water works should own and set all meters, the cost of the same to be provided for in a readiness-to-serve charge.

A city water department should, for accounting purposes, be considered apart from all other city departments, and be carried on so as to be a business on a paying basis, i. e., its rates must provide for all its expenses including interest, and provide such profit as will take care of casualties, etc.

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ELECTROLYSIS AND ITS MITIGATION. AN ACCOUNT OF THE WORK OF THE BUREAU OF STANDARDS ON THE SUBJECT OF THE DESTRUCTIVE EFFECTS OF ELECTRIC CURRENT ON REINFORCED CONCRETE AND UNDERGROUND PIPES AND CABLE SHEATHS, AND THEIR MITIGATION.

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Introduction.

The investigations of the Bureau of Standards on the general subject of the damage to underground pipes, cable sheaths, and reinforced concrete, by electric railway current and soil corrosion, have been carried on during the past four years.

The attention of the Bureau of Standards was first called to the importance of a study of the effects of electric current upon reinforced concrete by letters from engineers and companies seeking information as to the extent of the damage produced and the most practicable means of preventing it. Laboratory experiments had shown that under certain circumstances an electric current flowing from the reinforcing material into the concrete not only caused serious corrosion of the reinforcing metal, but sometimes also split open considerable blocks of solid concrete. These experiments had been repeated and confirmed by numerous experimenters, but theories to account for the phenomenon were conflicting and opinions as to the extent of the danger in practice were very diverse.

The corrosion of gas and water pipes by electric currents flowing from street railway tracks through the earth back to the power-houses was another phenomenon of electrolysis that for many years had been causing serious concern to the gas and water companies, and in more recent years at least to railway engineers also. It was recognized at the Bureau that a thorough investigation of these questions, for the purpose, first, of understanding the phe-

nomena better and, second, of learning the best methods of overcoming the trouble, would be of great practical value, and it was believed that such a problem, requiring years of consecutive observation and research, could be undertaken to advantage by a national institution, such as the Bureau of Standards. Accordingly, a special appropriation was asked for and granted by Congress, and work was begun in the summer of 1910. A number of related investigations have been carried out during the past four years, and some are still in progress.

Corrosion of Reinforced Concrete.

The investigation of the effects of electric current upon reinforced concrete was one of the first to be taken up. At the outset a number of experiments described by previous investigators were repeated in order to verify their results or to decide between conflicting conclusions. Numerous modifications of these experiments, and many entirely new ones, were instituted, and a very careful record kept of all details of the work, so that conditions could be accurately reproduced. The conditions under which an electric current can split open a solid block of reinforced concrete were investigated and the cause of this important and somewhat startling phenomenon was determined. It was also found that when an electric current flows through reinforced concrete toward the core there is an important cathode effect, such that the bond between the concrete and the reinforcing metal may be destroyed and the concrete cease to be reinforced. In addition to ascertaining the chemical and physical changes which occur, and clearing up certain hitherto unexplained phenomena, some practical conclusion of great economic value resulted from the Bureau's work. I cannot take time even to mention the principal results obtained, but can merely refer any one who is interested to our technological publication No. 18, an illustrated paper of one hundred and thirty-six pages.*

Electrolytic Corrosion of Iron in Soils.

A second investigation was on electrolytic corrosion of iron in soils, a subject of great practical importance because of the

* Sent free on request.

enormous quantity of iron gas and water pipe buried in the ground. For convenience we use the term "electrolytic corrosion" to indicate the corrosion caused by the discharge of an electric current which enters the metal from external sources. Other forms of corrosion, in which the currents originate in the corroding system from whatever cause, are designated as self-corrosion. These two forms of corrosion are not independent of one another, since the presence of either kind of corrosion generally affects the extent of the other. This mutual influence is of great importance, and must be carefully taken account of in electrolysis surveys. It is partly because of this effect that corrosion efficiencies greater than 100 per cent., sometimes as much as 150 per cent., are encountered; that is, the amount of the corrosion due to a given electric current may be as much as one and a half times as great as the amount calculated from Faraday's law, after deducting the natural corrosion that would have occurred if there had been no external current flowing. These cases occur with low-current densities. With high-current densities the efficiency of corrosion is relatively low, the iron tending to become passive, and showing corrosion efficiencies sometimes as low as 20 per cent. This is in marked contrast to the effect in concrete, where at high current densities the destructive effects increase more rapidly than the current increases.

Moisture has a marked effect, the efficiency of corrosion increasing with the moisture content of the soil up to saturation.

Temperature changes within ordinary ranges have no important effect upon the efficiency of corrosion. Temperature does exert an important influence in the total corrosion in practice by affecting the resistance of the soil.

The amount of oxygen present has a marked effect upon the end products of corrosion. If the corrosion is rapid and the supply of oxygen is limited, there will be a preponderance of magnetic oxide; if the rate of corrosion is slow and the supply of oxygen is plentiful, ferric oxide will predominate. Thus the nature of the oxide is an indication whether the corrosion is due to external electric currents, as rapid self-corrosion is unusual unless in the presence of cinders, coke, or chemicals.

Careful experiments were made to ascertain whether the effi-

ciency of corrosion is different in different kinds of iron. Eighty specimens were employed, twenty each of ingot iron, machinery steel, wrought iron, and cast iron, half of the latter being used as they came from the mold and half machined to a clean surface. The results showed almost exactly the same corrosion due to the current, although the self-corrosion of the cast iron was greater than for the others, being about 10 per cent. of the electrical loss. (The self-corrosion of the ingot iron was 3 per cent.; of the machinery steel, 4 per cent.; of the wrought iron, 5 per cent.) The superiority of cast iron respecting electrolytic and self-corrosion is due to higher resistance of the joints in the pipe lines, higher electrical resistivity of the iron, heavier walls of the pipe, and a tendency to corrode more uniformly

Other subjects investigated were the causes of the efficiency of corrosion exceeding one hundred per cent.; the corrosion efficiency at very low voltage; and the effect of moisture content, temperature, and pressure on earth resistance. It was found that the corrosion efficiency does not vary with voltage, the current being the same. Impressed voltages as low as 0.1 volt gave the same values as 1.0 volt. Corrosion tests on a large number of different kinds of soil from widely different sources with average moisture content and moderate current densities showed that corrosion efficiencies between 50 and 110 per cent. may usually be expected under most practical conditions.

Electrical Resistance of Soils.

The resistance of soils varies widely according to the moisture content, the resistance of comparatively dry soil being several hundred times the resistance of the same soil at saturation. Hence voltage surveys should not be made at times when the earth is exceptionally wet or exceptionally dry.

The resistance of the soil varies greatly with the temperature. At —18 degrees Cent., the resistance of soil was found to be over two hundred times as great as at +18 degrees Cent. At freezing temperature the resistance is many times the value at 18 degrees Cent. This has an important bearing on the magnitude of electrolysis troubles, and shows that the damage from electrolysis

due to street railway currents may be less in winter than in summer, even though the railway currents are then greatest. The rail resistance is least in winter when the soil resistance is greatest; both tending to lessen the current in the pipes. Electrolysis surveys, therefore, would better not be made in severely cold weather.

These results have an important bearing on electrolysis mitigation, and the fixing of limiting values to the current density in rails or voltage gradients in the earth, as well as an important bearing on the methods employed in electrolysis surveys.

Nearly a hundred samples of soil were collected from various cities, including Philadelphia, Pittsburg, Erie, St. Louis, and Washington, and their resistances measured. The soil samples of each city were from widely different locations, being taken from the depth at which pipes were buried and generally near gas or water pipes. The resistances varied through a wide range, according to the character of the sample, but the averages showed some interesting results. The values were much more uniform and lower in the St. Louis samples than in those from other cities, the smallest being 400 ohms per cu. cm., and the largest 1 800 ohms. The average resistance of 35 samples of St. Louis soil was five times less than of the 20 samples of Philadelphia soil.

These results also have an important bearing on the question of damage from electrolysis and the precautions necessary to protect gas and water pipes and cable sheaths from destruction by street railway currents. The Bureau had made electrolysis surveys in Philadelphia and St. Louis, and we had wondered why the former city was relatively so free from trouble due to electrolysis. There were differences in conditions in favor of Philadelphia in several particulars, but not until we found the great difference in soil resistance did we understand the great difference in electrolysis troubles.

The proposal to fix by state law a general requirement as to voltage drop or current density in the rails is seen not to be very logical, in view of the great variations in the damage which can result under different conditions with the same voltage drops. The full results of this investigation on electrolytic corrosion of iron in soils are contained in our technological paper No. 25. The

methods employed in measuring the resistance of soils and the results obtained will be published shortly in technological paper No. 26.

Surface Insulation of Pipes.

The fourth investigation in this series undertaken by the Bureau was on the surface insulation of pipes as a means of preventing electrolysis.

One of the first methods resorted to as a means of preventing damage to buried gas and water pipes by electrolysis and soil corrosion, and still used to a considerable extent, consists in covering the surface of the pipes with a coating intended to insulate them from the surrounding earth. In many cases pipes have been so protected from soil corrosion; but it is doubtful whether there is any instance on record where damage by electrolysis has been effectually prevented in this way if the voltage conditions were at all severe. On the contrary, there have been cases where such coatings have done actual harm, as they tend to fail in spots and so permit the current to escape from the pipes at such places with a greater current density than otherwise, and so aggravate the local damage.

To obtain reliable information as to the practicability of protecting pipes from electrolytic corrosion by means of paints or wrappings, the Bureau undertook an extensive investigation of all the materials on the market for the purpose. The materials available may be divided into three classes, as follows:

(1) Paints or compounds applied at ordinary temperatures.

(2) Dips or compounds to be applied hot, such as asphalts, coal-tar pitches, etc.

(3) Wrappings, consisting of alternate layers of compound and fabrics.

(In addition, experiments are in progress on fiber conduits, used with or without pitch filling, and made up with screw joints, and pipes with enamel coatings.)

Time does not permit me to describe the experiments carried out through a period of several years, partly in the laboratory and partly on specimens buried in the earth, but I can give briefly the conclusion, namely, that the paints, dips, and wrappings

tested were found to be of little or no value in protecting pipes from electrolysis when applied to the positive areas near power stations where the current is tending to leave the pipes. Repeated experiments have shown that all the materials tested increase in weight when immersed in water. Hence they absorb moisture in greater or less degree when buried in the soil, and so become slightly conducting. Experiments show that before breaking down they begin to transmit current. This small current generates more or less gas, which soon develops pressure enough to rupture the coating. In the anode specimens, rust spots appear at the places where failure occurs, and pits then rapidly develop. In cathode specimens gas breaks through the insulating film, although no rust occurs.

These coatings would be of greater value in negative areas, where the current is flowing toward the pipes; but in practice it is not possible to foresee what are to be positive and what negative areas, for changes may at any time be made as the railway distribution system is enlarged or altered. Where there are no appreciable earth currents, and protection against self-corrosion is desired, these coatings and wrappings may be used.

After very thorough and careful study of the problem with the coöperation of many manufacturers of the materials tested, the Bureau has come to the conclusion that money can be expended more profitably in other directions than in an attempt to insulate gas and water pipes from the earth. The full results of this investigation are contained in our recent technological paper No. 15.

Insulating Joints.

A fifth investigation in this series is on insulating joints and their effectiveness in reducing trouble due to electrolysis. There are great numbers of insulating joints of various kinds in use in gas pipe lines, the most common being cement joints. This was one of the first investigations made at the Bureau, and consisted in testing the mechanical strength of joints; measuring the resistance between adjacent lengths of pipes connected by such joints; determining the corrosion around such joints when a given difference of potential is maintained between adjacent lengths of

pipes, or a given voltage applied to a line containing many such joints; finding the amount by which the current is reduced when such joints are used as compared with the same pipe in the same soil with lead joints, and making field studies where cement joints and other kinds of insulating joints are used, including the methods of making joints in practice.

I cannot discuss the subject further than to say that we have found insulating joints of very great value in reducing the current in pipe lines, and so reducing the corrosion caused by such current. Where the potential gradients are high, the joints must of course not be placed too far apart, as in that case the potential difference at each joint would be sufficient to cause considerable joint electrolysis. There is still some difference of opinion among engineers as to the practical value of insulating joints, but our experience is that, while they should not be depended upon as the sole means of protection to pipes, they are economically and mechanically practicable, and are a very important auxiliary means of protection, particularly in the case of gas pipes. They are less often used in water-pipe lines.

Methods of Making Electrolysis Surveys.

Another subject to which we have given much attention, and which will shortly be discussed in one of our Bureau publications, is the methods of making electrolysis surveys. One of the objects of such surveys is to determine the over-all potential differences between different parts of a city, due usually to the street railway system where a grounded return is used, as in the overhead single-trolley system. When the negative bus bars of the power supply stations and substations are grounded, and negative cables are run out to the grounded tracks, there is established a region of low potential around the station, and large potential differences are often produced in the systems of gas and water pipes, lead cable sheaths, reinforced concrete, and any other conducting structures embedded in the earth. In consequence, electric currents of considerable magnitude flow through the earth from tracks to pipes at points more or less distant from the stations, and from pipes back to tracks or negative cables in the region

near the power stations. It is in the regions near these stations, where currents — sometimes of hundreds of amperes — are leaving the pipes and cables, that electrolysis is most severe. It is the purpose of these surveys, therefore, to determine not only the over-all potential differences, but also the differences of potentials between tracks and pipes, the current density and potential gradients in the rails of the tracks, whether the tracks are well bonded, and the location of defective joints, the approximate current flowing in the pipes wherever that can be conveniently done, — and especially where the damage from the electrolysis is most serious. The engineers of the Bureau have acquired considerable experience in such work. They employ methods which can be used by any engineer.

Methods of Electrolysis Mitigation.

TRACK DRAINAGE AND PIPE DRAINAGE.

Having made an electrolysis survey in any given place, and learned the condition of the railway and pipe systems, the next question usually is how to remedy the trouble. As already indicated, we do not believe it practicable to insulate the pipe systems from the earth, nor to prevent serious corrosion to the pipes if heavy electric currents are allowed to flow into and out of them again. There remains, therefore, two possibilities. First, to bring the current back to the stations by metallic conductors provided for the purpose in such a way as to keep the current out of the pipes almost entirely; or, second, to allow the current to get into the pipes and cable sheaths but provide metallic conductors for getting it out again without serious corrosion to the pipes. In other words, drain the current out of the tracks by insulated negative cables, keeping the tracks as nearly at the normal earth potential as possible, and insulate the negative bus bars at the stations, so they may be kept at any desired potential difference below the earth; or, drain the current out of the pipes by means of copper cables tapped into the pipes, the bus bars being grounded. These two systems may be briefly designated as the "Track-Drainage System" and the "Pipe-Drainage System," respectively.

No one will question that the first of these methods is to be preferred, if it can be carried out economically. By it we correct the evil at its source, and it is undoubtedly simpler in theory and on many accounts better in practice. It has, however, been thought by many to be prohibitive in cost, and has been very little used in American cities. The pipe-drainage system, on the contrary, has been strongly advocated, and, in one form or another, much used. The investigations of the Bureau of Standards, however, which have been extended over several years, and have included a considerable number of large and small cities, have convinced us that the pipe drainage system as a principal method of protection is not only complicated and expensive to install and maintain, but is in the long run not an adequate remedy for electrolysis troubles. On the other hand, the track-drainage system when properly designed and installed we find to be simpler and more effective and far less expensive than has been supposed.

The difference between the track-drainage system, with insulated negative feeders, and the ordinary method of reinforcing the conductance of the rails by means of bare copper wires, is very fundamental. In the latter, the copper and tracks must have a potential gradient sufficient to cause the current to flow back to the station, and if this is to be small enough to obviate electrolysis troubles (say 0.3 or 0.4 volt per 1 000 ft. as a twenty-four-hour average, equivalent to about 1 volt per 1 000 ft. at peak load), the joint conductance of track and copper cables must be very high; that is, a very large quantity of copper must be used, and this generally makes the cost prohibitive. On the other hand, if the negative cables and negative bus are insulated (except at the end connected to the track), the drop of potential over the cables can be such as to give maximum economy. That is, the quantity of copper can be so adjusted that the loss of power per annum in the negative return and the annual charges on the cables shall be approximately equal; in other words, the sum of the loss of power in the negative return per annum and the annual charges on the negative cables may be a minimum. This may require a drop three or four times as much on the insulated cables as would be permissible on the tracks, and the negative bus bar may be 10 or 20 volts, or whatever is necessary, below earth potentials.

Resistance taps would be inserted in the shorter cables, so that the drop in potential in the various feeders shall be nearly equal. For the sake of economy it is usual to have a smaller drop in the shorter feeders than in the longer, and so have a potential gradient on the tracks toward the power house. But this should be kept small, so as to keep down the tendency for the current to leave the tracks and return by way of the pipes.

If this were a gathering of electric-railway engineers, I should like to describe more in detail the results the Bureau of Standards has obtained in applying insulated negative feeders to electric-railway systems for the purpose of reducing electrolysis troubles. Our work has included both large and small systems, urban and interurban, and the results obtained as to economies that accompany and more or less offset the cost of electrolysis mitigation have sometimes surprised railway officials.

So far, I have said but little concerning the pipe-drainage system which has been used in this country more than any other system. Connecting the pipes in the positive areas to the tracks by heavy cables lessens the damage, but it greatly increases the current in the pipes; and this is a serious objection. Where insulating joints are in use, and wherever defective joints occur, it tends to increase the joint electrolysis. In repairing gas pipes it is necessary to put a jumper cable around a proposed break in the pipe in order to avoid the possibility of causing an explosion by the spark or arc when the current in the pipe, which may be heavy, is broken. Such drainage cables tend to lower the potential of the pipes drained, and so attracts current to them from other pipes and cables, thereby making them a source of danger to all other pipes not drained. To completely drain all the pipes in the complex network of a city is almost impossible, and to keep track of the changes in the railway system, and readjust these drainage cables when necessary, would be an immense undertaking. The system has rarely been carried into effect on a large scale, but has been used to a greater or less degree in many places. We have reason to believe that in many places where pipe drainage has been practiced serious damage from electrolysis is becoming evident.

Surveys Made by the Bureau of Standards.

The Bureau of Standards has made electrolysis surveys for St. Louis, Springfield, Ohio, and Springfield, Mass., and several other places, and has found in a number of cases that the economies of power effected in connection with the improvement in the roadway, the shortening of feeding distances, and provision of a proper return for the current, has been sufficient to yield a fair income on the cost of the changes and new construction. In St. Louis, the United Railways Company equipped a new station in accordance with plans worked out by the Bureau of Standards, and found that the results attained with respect to cost and electrolysis protection were in accordance with the advance calculations made by the Bureau. The Ann Avenue station afforded an excellent opportunity to test the theory of the insulated return system and make a comparison with the pipe-drainage system. In this station the negative cables were used insulated with the negative bus bar insulated from earth, and readings were taken on the potential drops and also on the current in 21 gas and water pipes. Then the bus bar was grounded and the cables used as though they were bare copper, and again the potential differences were measured, as well as the current in the pipes. It was found that with the insulated feeders the total current in the pipes was 65 amperes, whereas with the cables uninsulated and so a steeper slope of potential in the earth, the total was 273 amperes, more than four times as much.

While no attempt was made in this investigation to install a complete pipe-drainage system, some of the pipes near the station were temporarily tied to the tracks in order to determine the effect of so doing on the current in the pipes.

The current in the 21 pipes was increased by so doing from 65 to 85 amperes when the negative cables were insulated. When they were uninsulated, the current was increased by tying in the pipes from 273 to 844 amperes. Thus it is seen that with pipe-drainage the current is ten times as great in the pipes when the negative feeders are uninsulated as when they are insulated. These measurements show what is to be expected, — that the

current flow in pipes is greatly augmented when the pipes are connected to the tracks or bus bar near the station.

Measurements of differences of potentials between pipes and rails also show the great advantage of the insulated feeder system. The full result obtained on this experimental installation has been published in technological paper No. 32.

In Springfield, Ohio, an insulated negative feeder system was installed at the expense of the railway companies in accordance with the recommendations of the Bureau, and measurements were then made to determine the degree of improvement effected in over-all potential differences in the earth, and in the differences between rails and pipes. A joint report on the system and its results, addressed to the city manager of Springfield, was prepared by representatives of the Bureau of Standards and representatives of the gas, water, and telephone companies and the railway companies. The report recommended that the system of insulated negative feeders installed by the railway companies be continued and maintained and that a system of pressure wires be installed to facilitate measuring potential differences between each station and various points at a distance therefrom. That the railway companies agreed to this report voluntarily shows that they were satisfied that the system installed was to their interest as well as to the interest of the pipe-owning companies. The American Railways Company with commendable progressiveness is adopting this system on other railways under their management.

The Bureau of Standards has been coöperating with the city of Chicago and the Board of Supervising Engineers in charge of the surface railways of Chicago, and we hope to see one station fully equipped shortly as a demonstration of what can be done at a moderate expense toward mitigating the damage due to electrolysis in Chicago.

The city of Springfield, Mass., and the various utility companies affected recently asked the Bureau to make a complete electrolysis survey of that city and render a report as to the best methods of improving conditions with respect to electrolysis. This work was done in June, but the final report has not yet been completed, owing to other urgent work.

Coöperation between Pipe-Owning Companies and Railway Companies.*

One of the most important reasons why electrolysis conditions have not been remedied oftener by the railway companies is that the engineers of the railways and of the gas and water companies have not got together to study the question.

As an illustration of what can be done by coöperation, I may cite a recent experience of our own. A water company in California employed an engineer to make an electrolysis survey of its system and prepare a case against one of the street railway companies of that city, since the company refused to remedy conditions. The case was to be taken before the California State Railway Commission, and the Bureau of Standards was asked to send one of its engineers to look over the matter and see if the claims and proposals made by the water company were reasonable. The Bureau complied with the request with the understanding that our engineer was not serving the water company merely, but would be impartial as between the railway and water companies. When he had examined the case he saw that the system which the State Commission was to be asked to order the railway company to install was not the most economical possible, and that since two different railway companies were involved, it would be better to consider the whole problem at once, instead of trying to make a case against one at a time. He then proposed to these two railway companies that, instead of fighting the water company before the State Commission, they unite with the water company and the

***The Joint Electrolysis Committee.* In order to get some reliable engineering results as to current practice in this country and abroad, and as to results achieved by different methods, a joint electrolysis committee was established about six months ago, at the instance of members of the American Institute of Electrical Engineers. This committee has three members each of the American Institute of Electrical Engineers, American Gas Institute, Natural Gas Association, American Electrical Railway Association, American Railway Association, the American Telephone and Telegraph Company, and one member from the Bureau of Standards. The chairman is Mr. B. J. Arnold, of Chicago, past president of the Institute of Electrical Engineers, and the committee contains many men prominent as railway, gas, and electrical engineers. There can be no doubt that the committee will gather valuable engineering data, and do a good service in getting together representatives of the various interests concerned and having them study electrolysis mitigation as an engineering question. The committee agreed at the start that legal considerations and all questions of responsibility for damage should be excluded, and attention given to the scientific and engineering phases and to determining what had been accomplished in different countries. It is to be regretted that there are no representatives of the water-works associations on this committee.

representative of the Bureau of Standards in studying the problem, and finding in what manner and at what cost the railways could take care of their return current so as to eliminate further damage to the water pipes. When the railway companies saw that it was a clean proposition for an engineering study, not committing them in advance to the results obtained, they accepted the invitation, and after a most thorough and detailed study, including the cost of construction and increased operating costs, as well as economies effected, the four engineers (one representative each of the two railway companies, the water company, and the Bureau) agreed on the plan to be recommended, with the intention of asking the State Commission to order its installation, instead of making a fight before the Commission which the latter would have to decide.

In another case, a city asked the Bureau to recommend a form of enforceable ordinance which the city could pass that would compel the electric railway company to take care of its current so as to stop the damage to the city's water pipes. The Bureau advised the city that before passing an ordinance an engineering investigation should be made to determine exactly what should be done to remedy electrolysis conditions and ascertain what it would cost. Such an investigation was made and a report submitted by the Bureau to the city and to the utility companies concerned. The investigation showed that the trouble could be corrected by the installation of a moderate quantity of insulated negative copper, building one new substation and enlarging another. The cost was quite appreciable, but the saving in power thereby effected was large enough to cover the extra operating expense, the interest and depreciation on that part of the new construction not otherwise needed and leave a small profit, the correction of serious electrolysis trouble being accomplished without any real net expense, and the service on the railway as regards car speeds and car lighting being improved. The railway company was entirely satisfied with the report, including the estimates of cost of new construction and operation and savings of power and improvement of service, and indicated their intention to carry out the work promptly. I am sorry to say, however, that to date nothing has been done, although several months have

elapsed. The relation between electrolysis mitigation and improved electric-car service just alluded to is a matter of much importance.

Different Conditions Require Different Treatment.

Enough has been said to show that conditions with respect to electrolysis are very different in different places. Precautions that are sufficient in one place are insufficient in another; and changes or new construction that can easily be afforded by one company might be a hardship to another. Hence a uniform requirement on all railway companies, passed by a state legislature or by city councils, is not to be encouraged. On the other hand, a general statute or ordinance holding railway companies responsible for the destructive effects of their return electric currents and requiring them to take suitable precautions to minimize such effects would be reasonable. If the managers of utility companies will treat the question in an enlightened and progressive manner as an engineering and business proposition, and keep out of the courts as completely as possible, city councils and state legislatures will no doubt be patient and give them a chance to solve the problem in an economical and engineering manner. But if these managers assume a reactionary attitude and decline to do anything until forced to do so, they may be compelled to do in many cases far more than is necessary or reasonable.

How the Bureau's Work is Done.

In this work the Bureau of Standards is not acting as consulting engineers, to serve a single company or interest as against other companies or interests. On the contrary, the work is being done as a part of our general electrolysis investigation, and many of the results obtained are published for the benefit of cities, utility companies, consulting engineers, and all others interested. The records and information obtained by the Bureau are available to any one who visits the Bureau even before publication, and we have frequent calls from consulting and company engineers interested in these questions. If, as we expect, the practicability and advantage of the insulated negative feeder system is soon

completely demonstrated, it will not be long before its use will become more or less general and the Bureau of Standards will be able to turn its attention to other subjects. But so long as the practicability of this system is not generally admitted, and nothing better is devised in its place, and electrolysis conditions continue to get worse every year, as they are now doing in most places where the overhead trolley system is in operation, we expect to continue our work of investigation and education.

At the beginning, the Bureau bore the greater portion of the expense incurred in its surveys and reports, and utility companies that coöperated with the Bureau generally did so as a favor to us, which we fully appreciated. Now that the practical value of the results achieved are better understood, the expense is borne in larger proportion by the utility companies concerned, but in every case the Bureau acts as an impartial agency, just as mindful of the interests of the railways as of the pipe and cable owning companies.

Conclusion.

One peculiar feature of the electrolysis problem is that so many different interests are affected. The gas, water, telephone, electric light, telegraph, and signaling companies — and often many private owners — have pipes or cables affected by the electric current from the street railways. Heretofore the railways have generally claimed — and usually I think sincerely — that it was beyond their power to prevent the damage, and hence they could not be held responsible for it, — at least to the degree that they could if it was practicable to prevent it. Naturally the railways have favored the use of pipe coverings and pipe drainage as a means of reducing the damage that put much of the responsibility on the pipe-owning companies. The cable-owning companies have spent large sums of money in protecting their cables by drainage. This is more practicable for cables than for pipes, for the sheaths are usually continuous electrically; but it is far more difficult and more expensive when the potential gradient is large than when it is small. If the use of uninsulated negative feeders were the only method available for taking care of the return current, the railway companies could be excused for not

maintaining a low-potential gradient in the earth. But the use of insulated feeders is so much more economical that, generally speaking, there is no longer any excuse for permitting bad conditions. Just as soon as it is recognized to be practicable it will be deemed as necessary to spend money for negative conductors as for the positive feeders.

The method has been much used in Europe and to some extent in this country, but so little in this country that few engineers knew that it was used, and until very recently there were relatively few who believed it practicable. I know of no published account giving full particulars of the actual results obtained by such a system previous to the recent articles describing the work done by the Bureau of Standards.

I have laid a good deal of emphasis on the duty of the railway companies to take care of their return current, and of the need of applying the same kind of engineering talent and experience to this phase of plant construction and operation as to other phases. I wish also to emphasize the duty of the owners and managers of water works to coöperate with the gas and telephone companies and railways in studying the problem of electrolysis mitigation in an open-minded and progressive manner. Taking the matter into the courts is to be deplored. It is better to employ engineers to work together to solve the problem in a thorough and efficient manner than to employ experts to testify in court as to who is responsible or what are the damages. As the damage is cumulative from year to year, and the rate increases as the traffic increases, there will be no better time than the present to take up the matter.

DISCUSSION.

Mr. Robert S. Weston. I would like to ask Dr. Rosa to what extent internal electrolysis takes place from external influences, — that is, to what extent hydrates of the metals are produced in the stream of water within the pipe by external electrolysis.

Dr. Rosa. So far as I know, it is very unusual.

Mr. Weston. There have been instances where lead-poison-

ing cases have been alleged to be due to the action of the external electric current on lead service pipes affecting the action of the water on the lead, and it would be interesting to know whether you have ever had any cases of that kind in your experience.

Dr. Rosa. I don't know of any such. So far as the electric current is concerned, electrolysis is only produced either when the current is going to the pipe or leaving it, and that would be on the outer surface, so there couldn't be any effect of that kind due to current from an internal source.

Mr. William C. Lounsbury. What effect does moisture have?

Dr. Rosa. Moisture has a very great effect. If the soil is very dry the resistance would be very high, and as the moisture increases, the resistance decreases up to saturation of the soil. In addition to the varying amount of moisture, there may be varying amounts of soluble salts in the soil, and that would tend to make the resistance vary. If the soil is sandy and contains a considerable amount of quartz and mica, as is sometimes the case, the resistance is very high. That is one reason why the average resistance in Philadelphia is so high, because there is so much of that sort of dry and sandy soil containing quantities of mica. In some streets, also, there is more or less organic material which has seeped down from the surface into the soil, and that tends to reduce the resistance; but the soluble salts and water are the two principal things which reduce resistance.

Mr. Francis T. Kemble. I would like to ask Dr. Rosa if he has ever found pipes corroded or injured by reason of electric light wires being grounded on service lines.

Dr. Rosa. I am very glad to be asked that question, because it is one on which I have very decided opinions. The grounding of the secondary circuits of transformers is one of the most important safety measures of protection to the general public and the users of electric light. If the insulation between the primary and secondary breaks down from a lightning stroke, or from deterioration with age, or from possible defect in manufacture, it will bring a high voltage (2 200 volts perhaps, and sometimes more) into the house, and that is of course very dangerous. Therefore in the interest of safety to the users of electric light — and that includes a very large portion of the public — it is im-

portant that the middle point of the secondaries be grounded, so if it does break down the current can flow to the earth and, without the secondary wire being brought to a high potential, the fuse will blow and disconnect the house wiring from the line wires. The connection to the earth must be a very good connection, or it is of no value. To run a wire into dry earth is of no value, either in case of lightning rods or of transformers. The practical question is, therefore, how to get a good connection to the earth.

Some companies drive a good-sized pipe several feet into the earth, and with a solution of salt surrounding the pipe, they endeavor to make a good connection. But it is very difficult and very expensive to make a ground of that kind that will have a low enough resistance to be satisfactory and safe. To ground all the transformers in a system by such means, and do a thorough job so as to really protect the public, would be so expensive that I think the lighting companies would fairly claim that it was prohibitive. Many of them are grounding them by means of driven pipes, but I don't know of a case where the ground other than on the water systems is really satisfactory. When they connect to a water pipe there is no current flowing to the ground, and there is absolutely no electrolysis produced except when a lightning discharge or accident happens, and then it will usually be for a few seconds only. Therefore there wouldn't be as much damage to the water system in a hundred years as there would be in one day by the street railway currents frequently found to be flowing through a pipe system.

Therefore I hope that the water companies generally, after satisfying themselves of the truth of what I am saying, will consent to this practice and encourage the lighting companies to ground their transformers on the water system. The reason why the water pipes are better than an ordinary pipe driven in the ground is that the water pipes are generally connected metallically together, and so form an extended system in good contact with the earth, furnishing all together a good connection for the electric current to go through. To get so good a ground that the resistance is only one ohm requires a very large surface of pipe, and I don't know of any way that is really practicable and satis-

factory to ground these transformers except by connecting them to water pipes.

Mr. Kemble. They get the best ground in that way, and we are not hurt.

Dr. Rosa. And the electric companies will no doubt consent to pay for any damage that is produced, if any can be shown to be produced.

Mr. Charles W. Sherman. If I may ask one other question along the same line, I should like to know whether Dr. Rosa considers the practice of grounding the secondary of the transformer to the main pipe preferable to that of grounding the several house services upon the service pipes in the houses, which is, I think, the more common custom in this vicinity.

Dr. Rosa. Both should usually be done, although in some cases when transformers are near the house, one ground would be sufficient.

The President. I should like to ask Dr. Rosa if he sees objection to the practice of grounding secondary wires to house services in a district where the potential is strongly plus; in other words, would there be greater objection to this practice where the tendency of the current is to flow from the pipes than in a negative district where the tendency is otherwise.

Dr. Rosa. I don't think it will make a particle of difference. In regard to pipe grounds, of course it is very commendable in a company for it to go to the trouble and expense of securing a good ground without connecting with the pipes. We have been trying to get the results of actual experience, and if there is anybody who can give us actual results of measurements we should be glad to receive them. We have been making such measurements lately, and have spent considerable time in making the actual measurements of ground resistance of these outside pipes and plates which are used not only for electric transformers and circuits, but also for lightning conductors. In Washington they use this system of driving pipes outside, and they have spent a good deal of money and tried very earnestly to make a good connection. We sent one of our engineers out with an engineer from the company, not long since, to make measurements. He was confident that their grounds would show a very low resistance,

and he was surprised to see how high they were. That is, the resistance was not nearly as small as he thought it would be. We are extremely anxious to get actual measurements, and, if it can be shown that any company is doing this in a way to get good results, we will be the first to acknowledge it and to advertise it. What we are after is information, but we have not yet got enough to say that that is being done in a way which will give first-class protection. Merely to get a fair ground so that the current will flow to the earth is not enough. They sometimes get a thousand volts difference in potential in the case of a breakdown and it would be dangerous before the current ceased to flow.

Mr. Frank E. Merrill. Some years ago I presented a paper* on our experience in Somerville in regard to the grounding of the secondary wires of electric-light companies to water pipes. After a very careful investigation of the matter, and after having called in some electrical experts, we came to the conclusion that there was no harm to be done to the water pipes, and we granted permits to the electric company to attach their wires. I will add that our experience since that time has not given us reason to feel that we arrived at a wrong conclusion, for we have never had any trouble from that source.

Mr. Morris Knowles. Two things have suggested themselves to me. The doctor referred to the investigation of interurban systems as well as local systems. In regard to the former, many use the alternating current, and the first question which suggests itself is, — Has there been any difference found in the effect of alternating current and direct current?

The second question is suggested by his reference to the fact that reinforced concrete deteriorates when attacked by electrolytic action. I understand in one place where a large pipe had several holes and weak places, due to rusting through, that a reinforced concrete jacket was placed around the pipe. Now, are we to understand that probably that reinforced jacket itself will disintegrate and therefore the condition in the pipe line become as bad as ever?

Dr. Rosa. As to the question about the alternating current, it is true that the electrolytic damage due to the alternating

*Journal N. E. W. W. A., *23*, 180 (1909).

current is very much less than that due to the direct current. We have been making some experiments on that subject, but have not yet completed them and have not published any results. We can say positively, however, that the effect is very different indeed. Also, when direct currents are used, if the current reverses frequently, as it does as the traffic varies, the damage is less than when it is all flowing in one direction. That is to say, by the use of insulated feeders the current at certain regions in the tracks frequently reverses as the traffic changes. Sometimes it will be flowing away from the pipe, and a little later it will be flowing towards it, and that produces very appreciably less corrosion than if it is always flowing in one direction, provided the reversals are rather frequent.

As to the question of coating a pipe with concrete, — there are perhaps two questions in that. The concrete itself, buried in the earth, may be damp and a pretty good conductor of electricity. It is not, therefore, protecting the pipe from electrolytic damage. If the current flows along the pipe and out through the concrete to the earth, it will produce corrosion, although the concrete will preserve the iron from corrosion from the outside. If there is iron buried in concrete for reinforcing, if considerable current flows through it there may be corrosion of that iron. If the iron is so placed that the current flows into and from it so that the iron is an anode it will become corroded and at times it may break off the concrete around it; if it does not do that it may still become corroded enough to be weakened. If the current flows toward the iron from the concrete it may soften the concrete. If the current density is great, as it may be in exceptional cases, the damage may be severe, but generally it is not.

Mr. William F. Sullivan. I should like to ask what effect these currents have upon steel structures, such as viaducts and elevated structures. Does the electrolytic action go on in the overhead structures?

Dr. Rosa. In the case of overhead structures resting upon the earth, — columns, for example, resting upon a concrete foundation, — if the current is flowing down a column from an overhead railway it may produce rather serious corrosion. In New York City it was sufficiently serious so that the company spent half

a million dollars or more to insulate their structures, and at the present time the elevated railways in New York are not grounded to the structure as they formerly were, and the corrosion at the base of the columns was stopped by that means. There may be in some cases serious corrosion of that kind.

Mr. J. M. Diven. Track and pipe drainage is only a makeshift. The only absolute safety is to keep the current out of the ground. It can be done, and, being practicable, it should be required, even if it costs the electric railway companies more. In the long run it might prove cheaper for them than paying for damages to water mains and other underground structures.

Mr. Tannatt. I would like to ask the last speaker to go a little further and tell us how he would keep the current out of the ground.

Mr. J. M. Diven. By a complete metallic circuit, or, in other words, double trolley. Railroads with the double overhead trolley are in operation, and have been for a number of years, in Cincinnati, Ohio, and Washington, D. C. The New York underground trolleys all form a complete metallic circuit, so that no stray currents are found in the ground, except such as stray over from Brooklyn.

METERING AN OLD CITY.

BY JAMES A. MC MURRAY, ENGINEER IN CHARGE INCOME BRANCH WATER SERVICE, BOSTON, MASS.

[*Read September 10, 1914.*]

Every city and town should furnish its inhabitants with an abundance of good water, to promote their health and prosperity and protect their property from fire; and every one should help to conserve the supply by preventing its waste. To provide an adequate supply for a large city, an enormous outlay of money is necessary, and, of course, the burden must be borne by those who receive the benefits.

The Boston water supply, which cost \$27 000 000, was being rapidly exhausted when the Massachusetts legislature of 1895, exercising sound judgment, created the Metropolitan Water Board to conserve the sources of supply in the state and to furnish water to the cities and towns in the newly-created Metropolitan Water District. The city of Boston made remarkable progress in reducing waste with the Deacon meter system and a corps of waste inspectors. The Deacon meter system will discover the leaks, but without intelligent and faithful work on the part of the inspectors the waste cannot be permanently reduced. This system had been practically abandoned before the general installation of meters, as was evidenced by the high consumption in the city of Boston.

The Metropolitan Board, which acquired Boston's sources of supply, has expended up to the present time about \$42 000 000 in constructing the present system, and to meet this obligation the state levies an annual assessment of \$2 300 000 upon the cities and towns of the metropolitan district. Boston's annual share is about \$1 800 000, or 78 per cent. of the total. Various methods of levying the assessment were used; at the present time it is based upon the consumption and valuation — two thirds on consumption and one third on valuation. The present metro-

politan supply was deemed sufficient for all purposes, including increase in population and business, until 1930; but the ever-increasing consumption caused the Metropolitan Board to make an investigation to determine the cause of the unwarranted increase. This survey was made in 1903 and 1904. It was found that the consumption of 1903, 119 gal. per day per capita, should not have been reached until 1920. This condition could not be allowed to continue if the supply were to hold out.

In 1903 the state commenced to meter the mains supplying the cities and towns in the district to determine the consumption in the several cities and towns. This attempt to place the responsibility for the increase, and the coöperation of the local departments with the Metropolitan Water Board to reduce the consumption, accomplished some good results; but, despite every effort, the consumption continued to increase until it became apparent to all concerned that one of two things must be done: either an additional source of supply, involving the expenditure of a vast sum of money, must be procured at once,— and any outlay of money for this purpose would be an unwarranted waste of public funds,— or the waste must be stopped.

It was decided to stop the waste, and it was further agreed that the only sure way to stop it and reduce permanently the high consumption was to place the responsibility upon the individual, and meter every service pipe. To this end, the Massachusetts legislature of 1907 passed the following statute, which went into effect January 1, 1908:

An Act to Prevent Waste of Water in Cities and Towns Supplied from the Sources or Works of the Metropolitan Water District.

Be it enacted, etc., as follows:

Section 1. All cities, towns, districts or corporations which derive all or any part of their water supply from the metropolitan water works or from sources used by or under the control of the metropolitan water district shall after December thirty-first, nineteen hundred and seven, equip with water meters all water services thereafter installed for them and shall also annually equip with meters five per cent. of the water services which were unmetered on December thirty-first, nineteen hundred and seven; and shall also thereafter charge each consumer in proportion to

the amount of water used: provided, that no city, town or district shall, in any one year, contract for more than the number of meters to be installed by it during that year under the provisions of this act; and provided, also, that a minimum rate may be fixed for which the consumer shall be entitled to a stated quantity of water.

Sect. 2. The provisions of this act shall not apply to the water service for fire purposes only of any city, town, fire district or individual, nor shall such service be taken into consideration in computing metered water service. All water used for the supply of public buildings or other premises under the control of a city, town or district, and all water used from the public works for the flushing of sewers, watering of streets and all other purposes, except for the extinguishment of fires, may be paid for by the city, town or district.

Sect. 3. Meters shall receive the necessary care and maintenance to secure proper efficiency and shall be tested or replaced by the city, town, district or water company whenever there is reason to believe that the records furnished by them are inaccurate, or whenever the service furnished is in other respects inefficient. Cities, towns, districts and corporations may make rules and regulations relative to the care, maintenance and protection of meters, and for properly ascertaining and recording the amount of water actually used during specified periods by each water consumer. Proceedings for the enforcement of this act shall be instituted and prosecuted by the attorney-general upon complaint of any party in interest.

Sect. 4. This act shall take effect upon its passage.

Approved June 15, 1907.

This act was amended in 1909 to provide a penalty for failure to comply with its requirements, as follows:

An Act Relative to the Use and Care of Water Meters in the Cities and Towns of the Metropolitan Water District.

(Chapter 177.)

Be it enacted, etc., as follows:

Section 1. Section three of Chapter five hundred and twenty-four of the acts of the year nineteen hundred and seven is hereby amended by striking out the last sentence and inserting in place thereof the following: It shall be the duty of the metropolitan water and sewerage board to supervise and promote the enforce-

ment of the provisions of this act, and if any city, town, district or corporation violates or neglects in any respect to comply with the provisions hereof, said board shall forthwith give written notice of such violation or neglect, together with the facts relative thereto, to the attorney-general for his action in the premises. The supreme judicial court shall have jurisdiction, upon an information in equity filed by the attorney-general, to enforce all the terms and provisions of this act, — so as to read as follows: — Section 3. Meters shall receive the necessary care and maintenance to secure proper efficiency and shall be tested or replaced by the city, town, district or water company whenever there is reason to believe that the records furnished by them are inaccurate, or whenever the service furnished is in other respects inefficient. Cities, towns, districts and corporations may make rules and regulations relative to the care, maintenance and protection of meters, and for properly ascertaining and recording the amount of water actually used during a specified period by each water consumer. It shall be the duty of the metropolitan water and sewerage board to supervise and promote the enforcement of the provisions of this act, and if any city, town, district or corporation violates or neglects in any respect to comply with the provisions hereof, said board shall forthwith give written notice of such violation or neglect, together with the facts relative thereto, to the attorney-general for his action in the premises. The supreme judicial court shall have jurisdiction, upon an information in equity filed by the attorney-general, to enforce all the terms and provisions of this act.

Sect. 2. Said chapter five hundred and twenty-four is hereby further amended by striking out section four and inserting in place thereof the following: — Section 4. If a city, town, district or corporation in any year neglects or refuses to comply with the provisions of section one, it shall forfeit to the commonwealth for the use of the metropolitan water district not less than twenty dollars and not more than one hundred dollars for each day after the expiration of said year during which such violation or neglect continues. The penalties or forfeitures which may be incurred hereunder may be recovered in an action of contract brought in the county of Suffolk in the name of the commonwealth, or may be recovered by an information in equity in the name of the attorney-general at the relation of the metropolitan water and sewerage board, brought in the supreme judicial court for the county of Suffolk.

Sect. 3. Section one of this act shall take effect upon its passage, and section two shall take effect on the first day of January, nineteen hundred and ten.

Approved March 18, 1909.

At the beginning of 1908, when the meter law went into effect, there were in the city of Boston about 95 000 service pipes, 5 000 metered and 90 000 unmetered. It had been the practice of the department to meter railroads, wharves, large business buildings, hotels, and large apartment houses; in fact, practically every business building has been metered for a number of years. But no attempt had been made to meter premises where water was being wasted continuously and carelessly.

Now that the city was compelled to meter all premises, it was a question how to proceed in order that the waste of water might be restricted and the income not too heavily reduced. Of course there were no positive data as to the amount of water the different classes of houses would use, and there was no way of telling how much money would be derived after the meters were installed — in a word, whether the meters would increase or decrease the revenue.

It was decided, finally, to meter the large tenement houses and buildings with saloons, because it was presumed that great waste would be found in them. In many instances this was found to be true, though very often great waste was found in small houses.

During the year 1908 only a few meters were set, although under the act about 4 500 old service pipes and all new services should have been metered. In 1909, however, the department hastened to make up for lost time, because of the penalty which the legislature of 1909 added to the meter act for failure to comply with its requirements. A force of ten plumbers under the direction of a foreman was engaged in setting the meters. One or two plumbers were sent into each district to meter the buildings selected. Each plumber had a helper and a team with a driver; the team carried the men and the stock from house to house, the houses being very often widely separated. This method was used in 1909 and 1910. In 1909 6 584 meters were installed, and 6 615 in 1910.

In 1911, the Public Works Department was created, and under the direction of the Commissioner of Public Works the installation of meters by districts was begun. It was decided to send the larger part of the plumbing force into one district and meter every house. Each district was divided into sections and the

men were supplied with meters and fittings of all kinds from a portable storehouse; which was moved with the men from section to section. By this method the work was done more quickly and economically, and, furthermore, important data were obtained.

The first district metered was East Boston, where 5 000 meters were set in the year 1911. The water for this district is measured by two Venturi meters. In 1911 the consumption was 5 511 000 gal. per day, 95 gal. per capita; after the district was wholly metered the consumption fell to 3 586 200 gal. per day, 58 gal. per capita. The second district metered was Charlestown, where 4 000 meters were installed in 1912. The consumption in 1912 was 6 860 200 gal. per day, 168 gal. per capita; in 1913, when the district was all metered, the consumption dropped to 4 394 200 gal. per day, 107 gal. per capita.

The following table gives the daily and per capita consumption in Charlestown and East Boston from 1910 to 1913, showing the remarkable drop in consumption in both districts due to the installation of meters:

	Charlestown.		East Boston.	
Year.	Daily Consumption. Gal.	Per Capita. Gal.	Daily Consumption. Gal.	Per Capita. Gal.
1910....	7 552 700	187	6 172 600	110
1911....	7 528 000	185	5 511 000	95
1912*...	6 860 200	168	4 416 200	73
1913†...	4 394 200	107	3 586 200	58

The following is a statement of the daily consumption in East Boston and Charlestown, also of the daily and per capita consumption of water for domestic and for manufacturing and mercantile purposes in these districts in 1913.

East Boston.

Total Daily Consumption. Gal.	Per Capita.		Daily Consumption. (City Meters.) Gal.	Per Capita. Gal.
		Domestic,	1 241 007	19.5
		Manufacturing and Mercantile,	1 344 431	21.5
3 586 400	58		2 585 438	41.0

* East Boston went under meter rates in 1912.

† Charlestown went under meter rates in 1913.

CHARLESTOWN.

Total Daily Consumption. Gal.	Per Capita.		Daily Consumption. (City Meters.) Gal.	Per Capita. Gal.
		Domestic,	885 291	21
		Manufacturing, and Mercantile,	2 118 164	50
4 394 200	107		3 003 455	71

It is interesting to observe that in East Boston the city receives income from 73 per cent. of all the water furnished the district, and 70 per cent. in Charlestown. It is also to be noted that the underground waste in East Boston amounts to 17 gal. per day per capita, and in Charlestown 36 gal. per capita. While great results have been accomplished in reducing inside waste, it is evident that outside waste must not be ignored.

In South Boston, 5 000 meters were installed last year, but the results will not be obtained until the end of the present year. At the present time, the North and South End districts of the city are being metered.

By metering every house in a district, the coöperation of the owners was secured and a campaign of education was started among themselves. Everybody wanted to know something about these dreadful machines. The department coöperated with the residents in every way. Before a district was placed under meter rates each meter was read at least twice, and if leaks were found on the premises the owners were notified in due season. If very bad leaks were found, for sometimes the waste was enormous, and the owner did not stop the leaks, an inspector was detailed to hunt him up and inform him of the waste and to advise him further that if the waste was not stopped immediately the water would be shut off. Circulars were distributed throughout the district, advising the people that meters had been installed in every house and that it was necessary to watch the fixtures in order that the water bills might be satisfactory, and special notices were printed in the local papers giving the same general information.

Much opposition was encountered when the district installation was begun, because of the many wild and extravagant statements of individuals in regard to the meter water bills. No attention had been paid by these dissatisfied individuals to the notices given them of the great waste on their premises. They

had become accustomed to ignore the notices of the waste inspectors, and, therefore, failed to heed the warning that the premises were under meter rates and that the leaky fixtures would cause large bills. When they received their first meter bill they had their first awakening as to the great quantity of water that was being wasted on their premises. Even after they had received their first meter bill many of these people failed to make the necessary repairs, and received a second and a third large bill. Finally they began to realize that if they were to get normal bills it would be necessary for them to keep their fixtures in order. In each district we met with the same general difficulties. Some people in each district refused to admit us or offered some plausible reason for not allowing the meter to be set inside; this was for the purpose of preventing the installation of the meter. But when they realized that every house must be metered they were glad to have the meter installed on the inside in order that they might read the meter and keep control of their consumption.

One of the greatest difficulties to overcome was where one service pipe supplied several houses which were built and owned by one man, but now owned by several individuals. To install one meter and render one bill would cause no end of trouble. Therefore the corporation counsel was appealed to, and he advised the department to lay a separate service pipe for each house and meter it, without cost to the owner. Then, again, in private ways two or more houses were supplied from one private main. In following the practice of the department to control underground leaks in private ways, we should install the meter at the head of the place. However, this would not do, as we would be unable to determine how much water each house had used. Again the advice of the corporation counsel was sought and he suggested that the department secure a right-of-way in these places and assume control over the pipe and services and to set a meter in each house. This was done to the satisfaction of the department, because in case of leaks the department now has the right to make repairs or replace the service pipe with a more suitable one.

Most frequently, and especially in the old houses, the service pipes run the length of the house to the rear under the floor and

the plumbing is very complicated. It requires the most careful examination to discover where the branches are located in order that the meter will measure all the water used in the house. Very often the branches are taken off close to the wall, and if a careful inspection is not made the meter may be apparently installed in the proper position and yet not cover important branches.

Very often we have found two and sometimes three service pipes in a dwelling-house. Of course, several service pipes are often found in a large building where formerly there were several smaller buildings. Wherever several service pipes are found we endeavor to eliminate all but one. Sometimes it is necessary to lay one large pipe and abandon the smaller ones. In this way we have but one meter to install and repair and to read, and but one account to open for the building. Generally the department does not abandon the surplus service pipes without the consent of the owner, although it has been done without his knowledge and without any inconvenience to the occupants of the building. The plumbers are expected to make a very careful preliminary inspection of the premises before installing a meter. Needless to say, however, sometimes their inspections are rather faulty and some of the fixtures are overlooked.

After a district has been metered, an inspection of each house is made by special inspectors, to make sure that every fixture is covered and also to see that every house has been metered.

Iron pipes, and we are finding a great many of them, are causing the department much trouble, because after a meter has been installed and the water turned on the owners complain that the supply is insufficient. Of course, it is true that in these cases the supply is very often greatly diminished; and to improve the supply the pipes must be cleaned as thoroughly as it is possible to clean iron pipes.

Many stopcocks had not been used for years until operated by our plumbers when setting the meters, and whenever an owner is obliged to use one and fails to find it in satisfactory condition the department is charged with poor workmanship. There was a wholesale attempt at one time to have the department install new stopcocks where the least defect was found in the old ones; but this, of course, the city refused to do because the department

had not damaged them. In many instances our plumbers noticed that the stopcocks were very defective, and instead of shutting the water off in the cellars went outside and shut the water off in the street. This did not prevent the owners from asking for new stopcocks; but when they were convinced that our men had not used the stopcocks in the cellars they withdrew their claims.

On January 1, 1914, the department had 41 168 meters in service, about 36 000 having been installed since 1909; 5 000 of these meters are set in outside boxes in the sidewalk. The meters are generally set in the cellar, either on shelves or in ground boxes, where the meters are protected by wooden boxes 14 in. deep with a light iron frame and cover. The meters set on the outside are 4 ft. from the surface in concrete boxes with iron frame and cover; these boxes are large enough to allow a man to enter and remove or change the meter without removing the box.

During the year 1912, about 900 meters were affected by the frost; about one fourth of these were eventually condemned as useless and the others, after repairs of one kind or another, were redeemed for service. In 1913 about 1 600 meters were affected by frost; some were but very slightly affected and others were removed when the pipes in the houses became badly frozen, even though the meters were not affected. In 1912 about 170 meters in outside boxes were affected, mostly in East Boston, where there are about 1 200 outside meters. In 1913 only 30 outside meters were affected.

The city has installed about twenty Detector meters, ranging from four inches to ten inches in size, on lines furnishing water for both fire and other purposes. No other type of meter would be allowed by the fire underwriters.

All meters are set by employees of the department. The only work done by contractors is the digging and backfilling, and the hauling and setting of boxes for outside meters. In addition to the work of repairing and testing meters which have been in service, the department tests every new meter before it is installed. During the past year 4 000 meters were changed, 600 discontinued, 11 000 tested, 4 000 repaired in the shop and 600 in service, and 7 400 meters were installed.

The following table gives the number of services, etc., and shows

the wonderful results obtained from meters in the past six years in Boston and the Metropolitan District.

Year.	City of Boston.						Metropolitan District.		
	No. Services.	No. Meters.	Percentage of Services Metered.	Population.	Daily Consumption. (Gal.)	Daily per Capita. Gal.	Population.	Daily Consumption. Gal.	Daily per Capita. Gal.
1908	94 960	5 380	5.7	643 810	98 379 300	153	973 320	125 441 000	129
1909	96 132	12 048	12.5	659 110	94 029 900	143	997 760	119 119 100	119
1910	93 780	18 467	19.7	671 400	87 346 700	130	1 022 230	112 092 100	110
1911	95 037	25 206	26.5	688 520	85 571 500	124	1 046 630	109 994 800	105
1912	99 700	34 565	34.8	718 900	90 037 500	125	1 086 690	116 230 700	107
1913	101 100	41 168	40.7	726 975	79 391 600	108	1 125 232	103 847 700	94

In the foregoing it will be observed that while the city is only 40.7 per cent. metered, the per capita has been reduced from 153 gal. per day in 1908 to 108 gal. in 1913.

Now, a word about the revenue from water. Without money the city could not maintain its large system, pay its large metropolitan assessments, and install and maintain meters. During the past year \$3 031 600.36 were received, \$2 051 523.76 from meter rates, \$895 687.12 from annual rates, and \$84 389.48 from service pipes, etc.; 200 000 bills were issued — 140 000 meter and 60 000 annual bills. When the city is entirely metered 100 000 bills quarterly will be issued.

A water bill is not a lien in Massachusetts on real estate, as taxes are, and therefore it is necessary for the city to follow the payments as closely as possible.

Many complaints are received about large bills. The causes are generally defective fixtures, underground leaks, carelessness, and cold weather. Underground leaks cause much annoyance to the city and the consumer. They are very difficult to find at times, and the city sends a special inspector to locate them as nearly as possible for the owner. When these leaks are repaired 50 per cent. of the excess consumption is allowed. This amount is allowed by all the departments in the country. In no other cases are abatements allowed, although during the past two

winters the commissioner has made small abatements on excessive bills caused by very cold weather, and his ground for so doing was because of the many buildings that are still unmetered in Boston and which still waste a great amount of water in the wintertime.

When meters were first introduced the public anticipated large bills and the city a large reduction in income. But, in conclusion, I think that all must agree that the water meters are accomplishing great results in Boston and the Metropolitan District, are giving satisfactory bills to the careful public, and providing, up to the present time, more than enough revenue for the needs of the department.

DISCUSSION.

Mr. A. A. Reimer. This paper, I think, will lend force to our argument for meters in the older cities. There has been held up before us all the bugaboo of depleted revenue, that we would not get enough money to run the works with everything metered, and so on. But experience after experience during the last ten or fifteen years has shown that metering does not cut down the revenue to the danger point, at any rate. There may be some little decreases here and there, but the total decrease is not sufficient to be a dangerous one, and Boston's experience only parallels that of others that we have on our lists. I feel that this paper should be carefully studied by us all and we should put it down in our memories carefully, so that when we are faced with this argument it will be just one more weapon added to our list.

Our experience in East Orange has been exactly what you have here. In fact, we are making more money with the meters, although we are only about 35 per cent. metered, than we were with the old flat rates. Seventy per cent. of our people who were on the flat rates and now have in meters are saving money, and the city is squaring the account out of the other 30 per cent., and we are not a bit afraid for the future.

I am not at all conversant with the Massachusetts law. Evidently you are not quite as well fortified by your law here as we are by ours because of some of the features that Mr. McMurray has mentioned. I notice that your corporation counsel has

ruled that you would have to put in free services where there has been one service for several houses under different ownerships. We politely but firmly tell the owners to put in service pipes at their expense, and the law backs us up.

As to the question of piping underground in the basements of the houses, we are very arbitrary. We insist that the owner must have his piping taken out from underground, or we will pipe to a certain point and set the meter at that point, all piping ahead of the meter to be exposed. We do that for the sake of controlling the character of the material used from the main to the meter. We lay our services all the way from the main to the house line, and when we set a meter inside we want to know that the proper material is used, and have it exposed so when the inspectors go in they can see if there is a line of pipe between the foundation wall and the meter, and whether or not there has been any tap taken off. In that way we have been able absolutely to eliminate the illegal use of water by taps ahead of the meter.

The President. I might say in regard to the decision of our corporation counsel that there is more equity in it, perhaps, than one not knowing all the conditions might think. In each case, so far as I recall, the pipe originally had been a private pipe, paid for by the owner or owners, and for many years, in some cases I recall in South Boston for thirty or forty years, we had been receiving revenue from something which cost us nothing at all. Knowing the conditions it seemed to me very reasonable, in equity as well as in law, that the corporation counsel should have decided as he did.

Mr. Francis T. Kemble. In New Rochelle we are metered practically throughout, and we don't have any trouble to speak of. It is a decided benefit to the small consumer, as against the flat rate. We insist on lead services from the main to the meter, and we own them from the main to the property line.

Mr. McMurray. Last year out of 36 000 meters in operation we found that 5 000 users paid the minimum rate.

In the city of Boston we have not yet reached that class of houses, but when we come to the south part of the city, to Roxbury, Brighton, and Dorchester, we will have a considerable number of that very class. There are a considerable number of

people in certain districts who are now clamoring for meters, and are willing to put them in at their own expnse, but of course we are endeavoring to place them where we think they will do us the most good, and we think that up to the present time our judgment has been correct.

THE USE OF OZONE AS A STERILIZING AGENT FOR WATER PURIFICATION.

BY S. T. POWELL, CHEMIST AND BACTERIOLOGIST FOR THE BALTIMORE COUNTY WATER AND ELECTRIC COMPANY.

[*Read November 11, 1914.*]

It would be superfluous to recite here the nature and production of ozone, as the subject has been discussed so often in technical journals within the last few years that the basic theory as to the electrolytic manufacture of this gas must be more or less familiar to all members of the engineering profession. So many problems, however, have been encountered in attempting to apply this method of water purification, and so many failures have been experienced, in this country at least, that a discussion of difficulties encountered in the method may prove of value.

It is a well-known fact ever since the time of Schönbein, and more especially since the careful studies of Tyndall, that ozone is one of the most powerful oxidizing agents known, and when a sufficient amount of the gas is brought into direct contact with certain organic substances, the combustion of these products is rapid. This property, of course, renders the gas a powerful bactericidal agent and one well suited for water purification, especially as it is harmless, as are the products of oxidation. In addition to the bacterial efficiency, ozone will materially reduce the color and organic suspended solids and remove certain odors that are at times present in many water supplies. Notwithstanding the many advantages attendant with ozone treatment for water, the systems installed have for one reason or another not been eminently successful. Many of the systems abroad have been efficient, but the cost of operation has been excessive; others have not only been costly to operate, but the results have been altogether unsatisfactory. The systems installed at Ann Arbor,[1] Mich., and Lindsay, Canada, are notable instances of this fact.

Before entering into a discussion of the causes of failure that

have been experienced, it may be well to give a brief résumé of the results of our experimental work and the conclusions that have been drawn from these tests. This experimental work covers a period of about five years, and was undertaken by the Baltimore County Water and Electric Company in perfecting its ozone plant. The laboratory work has been carried on by the writer under the supervision of Mr. A. E. Walden, chief engineer and superintendent.

This system was installed by the Water Improvement Company of Philadelphia for the purification of the Herring Run supply of the Baltimore County system. The ozone generators were similar to the well-known Bridge type, using, however, cylindrical aluminum electrodes and micanite dialectrics instead of the aluminum and micanite plates as originally designed. The mixture of ozone and water was effected by means of aspirators and mixing wells.

The system was inefficient, due partly to faulty generators, but mainly on account of the mixing device, as has also been proven by the inefficiency of the Ann Arbor plant, which was of the same general design. In redesigning the plant it became necessary to eliminate many of the original features and add others. The system as it exists at present maintains the same general type of generators, but these are cooled with artesian well water instead of by oil, and the unozonized air is cooled and dried by refrigeration before reaching the plant, which was not a feature of the original design. The greatest changes, however, that have been made were in the design of the aspirators and the mixing chambers so as to obtain a better mixture and a longer contact period of ozone and water. The operation of the entire system is much more flexible than formerly was possible, and the production of the gas is now easily regulated.

Although provision has been made for filtering the raw water previous to ozonizing, this has not been done excepting for short periods. For this reason the plant has been put to the test of treating a water containing a considerable amount of suspended matter, much of which is due to organic solids, principally algæ growths. Because of this condition we have been afforded an opportunity to study the effect and efficiency of ozone upon

highly colored water containing a material amount of organic suspended solids and high bacterial counts. The results of these studies have proven the efficacy of ozone for water purification when the gas is generated in sufficient quantities for the treatment of the water, and is thoroughly mixed and allowed to remain in contact with the water for a sufficient period of time.

COLOR REMOVAL.

Much has been written concerning the bleaching effect of ozone upon colored waters, and there are many data to prove that this treatment is 'exceptionally efficient in removing organic stains. There has, however, been considerable discrepancy in the percentage removal effected by different plants, some plants giving high color reductions and others showing practically none. These differences are due in part to the difference in efficiency of the separate systems, but mainly to the character of the coloring matter contained in the supplies.

The Herring Run ozonators showed no uniform color reduction from day to day with a fairly uniform ozone production and identical operating conditions. Experiments [2] undertaken to determine this phenomenon showed that with water colored by organic stain, as from decayed vegetable growths, the waters were easily bleached, but that ozone had no bleaching effect upon waters stained by chlorophyll and similar compounds that were present in the supply in a free state, due to the disintegration of algæ and similar micro-organisms. As would naturally be expected from these results, the percentage of color removal will be proportionate to these compounds that are present in a supply.

REMOVAL OF ODORS.

The controversy that has been carried on through the various journals by different investigators in reference to the ability of ozone to remove odors has lead to much research in an effort to determine the deodorizing value of this gas. Most of this experimental work has been carried on in reference to the removal of odors from the atmosphere, and little or no work has been undertaken in reference to the removal of odors from solutions.

In our tests here it was demonstrated that certain odors could be readily removed; others were removed with difficulty, or not at all. The odors arising from the presence of algæ and other micro-organisms were eliminated by ozonization only after the organisms were removed by filtration. If this was not done, the odors were intensified, owing to the disintegration of the plants, causing the odoriferous oils to be scattered through the water.

The removal of odors by ozone, either from water or from the air, depends upon the oxidation of the odoriferous substance and, therefore, must be considered from a quantitative standpoint, namely, that a given amount of O_3 will be required to oxidize a specific compound according to the oxidation reaction. Franklin[3] and J. C. Olsen[4] have both proven this in their experiments, and some of these tests have been confirmed by the writer in similar tests.

In attempting to remove odors from a water it should be determined if the substance causing the odor can be readily oxidized, and if so, the volume of O_3 that will be necessary to complete the reaction.

BACTERIAL EFFICIENCY.

As to the efficacy of ozone as a sterilizing agent there is no question, as this has been proven time and again by various investigators. The failure of ozone systems to adequately sterilize certain water supplies has been due not to the failure of ozone as a germicide, but either to the insufficient production of the gas, improper mixture of ozone and water, or insufficient contact.

In the following tables is given the results of tests from the Herring Run plant, showing the exceedingly low concentration of gas necessary for sterilization with sufficient mixture and contact. These results are particularly interesting considering that the supply was not filtered.

TABLE 1.

SHOWING THE EFFECT OF OZONE UPON THE COLOR OF WATER WITH LOW CONCENTRATION OF THE GAS AND UNDER VARYING WEATHER CONDITIONS.

Date.	Color in Parts per Million.		Percentage Removed.	Temperaature Air. Deg. Fahr.	Humidity.	Ozone Concentration. Grams of O_3 per Cu. M. of Air.
	Raw Water.	Ozonized Water.				
12/ 3/13	35	15	57.2	48	88	1.69
12/12/13	30	20	33.3	40	58	2.54
4/27/14	28	18	35.7	68	68	0.76
7/27/14	28	20	28.5	80	68	0.90
8/ 5/14	28	20	28.5	80	76	0.84
8/ 7/14	28	20	28.5	78	80	0.63
8/18/14	50	40	20.0	82	80	0.63

Water not filtered before ozonizing.

TABLE 2.

SHOWING THE BACTERIAL EFFICIENCY OF OZONE BY PROPER MIXING AND CONTACT AND WITH LOW CONCENTRATIONS.

Date.	Bacteria per C.C.		Percentage Removed.	Temperature Air. Deg. Fahr.	Humidity.	O_3 Concentration.
	Raw Water.	Ozonized Water.				
2/18/14	2 720	25	99.1	30	90	1.05
2/20/14	1 600	16	99.0	24	80	1.77
2/26/14	1 400	8	99.5	34	76	1.26
4/25/14	1 580	56	96.4	54	70	1.27
8/ 3/14	740	16	97.8	78	64	0.58
8/ 5/14	*400	40	90.0	80	76	0.84

Supply unfiltered.

COST OF TREATMENT.

It is rather difficult to give any correct estimate of the cost of treatment in this country, as up until the present time no plant of sufficient capacity has been operated successfully. The cost of sterilization at the Herring Run plant, a ten-million-gallon

* High turbidity in raw water.

unit and in operation five years, cannot be considered as a criterion, as many of the items entering into the operation are development costs and cannot be readily segregated from the whole. Details of operation and construction costs of foreign plants are on file, but these are of little value in determining an estimate of ozone sterilization in this country. An approximate estimate based upon cost of sterilization here will be between $2.50 and $4.00 per million gallons, and considerably less than this if it is not necessary to filter the supply previous to ozonizing. This is based upon a maximum installation cost of $5 000 per million gallons on ten-million-gallon units, or larger installations, which includes roughing filters and refrigeration plant, interest on the investment at 5 to 5½ per cent., depreciation at 5 per cent., current at a maximum of 3 cents per kw., as well as supervision and management.

CONCLUSION.

To recapitulate, ozone treatment for water will be efficient for the following:

Removal of certain organic colors that are present in a water, either in solution or in a colloidal condition.

Elimination, or at least reduction, of odors.

Removal of bacteria without the addition of objectionable chemicals or leaving any detrimental after-effects from the treatment.

It is not the object of this paper to present this method of treatment as a cure-all in the art of water purification, nor, indeed, to lay claim that the system is better under all conditions than the present systems in vogue. It must be granted, however, that there is much that appeals in the method from an esthetic standpoint, and this alone has a value.

There are undoubtedly certain types of water that can be more efficiently and economically treated in this manner than by other systems. I have in mind those classes of waters containing but a slight amount of suspended solids, or suspended matter, in such a state that it can be readily removed by roughing filters operating at high rates; highly colored waters, or well water containing odors or subject to contamination.

It is not surprising that the majority of sanitarians view the value of ozone with considerable skepticism, owing to the failure of the process, either because of high operating costs or inefficient bacteriological results. These conditions have been brought about because of a lack of certain mechanical details in the design and construction of the generators and improper design in the mixing chambers.

From the results of our experimental work we are lead to believe that ozone will be found efficient and economical for water purification, provided that due consideration is given to the adaptability of the method for the particular supply in question, and if the generators and mixing devices are properly designed.

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THE SALEM FIRE.

BY F. A. MC INNES AND CLARENCE GOLDSMITH.

[*Read September 10, 1914.*]

The comparative equanimity with which such a disaster as the recent Salem fire is received by the community in general is little short of marvelous. For a short space of time there is intense interest; the reasons therefor are pointed out; methods of prevention are freely discussed; sympathy is extended in a substantial manner; and yet, the necessary lesson is not learned. What a travesty upon our civilization the story is! The direct fire loss in the United States and Canada in twenty months amounts to a sum of money sufficient to build the Panama Canal: the indirect loss cannot be estimated but is largely in excess of the actual property loss: in addition, enormous sums are spent in maintaining fire departments throughout the country which, owing to conditions obtaining, are powerless to prevent the criminal loss of life and money. With the exception of the present barbaric war in Europe, is there elsewhere throughout the world such an example of preventable waste? It is perfectly obvious to any thinking or unthinking man that the first step to prevent this terrible economic loss is to improve existing conditions; nevertheless, the danger confronting all of our cities and towns is allowed not only to continue but to very greatly increase each succeeding year.

It is the intention of the writers to make an analysis of certain conditions at the Salem fire which have neither been touched on by news items or by reports already published, but which, nevertheless, are of vital importance to those who are devoting their lives to maintaining water supplies adequate for preventing fires from reaching conflagration proportions.

Before the fire was subdued by the flank attack of 27 engine companies, 253 acres were burned over, involving the destruction of over 1 700 buildings at a loss in excess of $14 000 000, all in the short period of thirteen hours. The rapid progress of the fire

can best be shown by the statement that flying embers set fire in South Salem in forty minutes, and by the further fact that the military call was sounded fifty-four minutes from the time the first alarm was given.

The point of origin of the fire, on Boston Street, between Proctor and Pope streets, was immediately adjacent to a 20-in. main of the Salem distribution system where a normal pressure of a little more than 50 lb. obtained. The building in which the fire started, and those surrounding it, were of frame construction and mutually exposed each other, thus enabling the fire to spread with such rapidity that the adjoining buildings were almost immediately involved. Two of these were protected by automatic sprinklers. Before the first hour had lapsed, 10 engines were at work, and a conservative estimate based on a careful study of lengths of hose lines, sizes of nozzles, and water pressures maintained at the engines, shows that at no time during this period was more than 2 500 gal. of water per minute pumped from the distribution system, yet the recording pressure gage maintained by the Salem Water Department on Church Street registered a drop in pressure from its normal of 42 lb. to 20 lb. at the end of the hour.

That these engines with an aggregate rated capacity of 6 750 gal. were delivering this apparently small quantity of water may at first thought seem incredible when the exigency of the occasion is considered, yet a review of actual performances in Boston, where the engines are well maintained and are operated in a skillful manner, where hydrants are closely spaced and much three-inch hose is used, and where the water supply is ample, shows the following quantities delivered at several large fires:

Date.	Location and Alarms.	Capacity of Engine. Gals. per Min.	Maximum Delivery of Engines. Gals. per Min.
7/5/04	B. & M. Grain Elevator, 4 alarms	12 900	3 500*
7/30/04	B. & A. Grain Elevator, 4 alarms	12 000	5 556
11/17/04	Hoosac Docks, 4 alarms	12 500	4 653
3/5/10	N. E. Building, 5 alarms	16 300	10 400† 8 330‡
8/9/10	Albany and Dover streets, general alarm	27 700	11 670§ 15 500‖
6/11/14	Condor and Border streets, 4 alarms	13 100	6 458

* Hydrants on one side of building only.
† Maximum for ten minutes.
‡ Average for one hour.
§ For one-half hour.
‖ For a few minutes.

In the above figures the amount of water pumped was determined by Venturi meter measurement.

The Marblehead engine arriving at 2.15 P.M. was unable to get water either from the hydrant on Broad Street, between Flint and Jackson streets, or from the hydrant at Broad and Jackson streets, while the Swampscott engine, arriving at 2.10 P.M., and the first Lynn engine, arriving at 2.25 P.M., were seriously handicapped by lack of water.

At the beginning of the fire, the 20 000 000 gal. reservoir was practically full, the two 5 000 000 gal. pumping engines were in operation under a full head of steam, the 30-in. and 20-in. supply mains were in service, and no breaks occurred in the street mains during the progress of the fire.

A test of the carrying capacity of the distribution system was made on August 31, 1914; the method of making this test was as follows:

Four chucks were set on hydrants along Boston and Federal streets, east of Proctor Street. These hydrants were opened, two discharging through three $2\frac{1}{2}$-in. outlets and two through four $2\frac{1}{2}$-in. outlets, and, in addition, a post hydrant in an adjacent alley was discharging through two $2\frac{1}{2}$-in. outlets. The flow from each of the 16 outlets was measured by Pitot tubes and showed a total of 8 585 gal. per minute. The drop in pressure in the 20-in. main at the point where the test was made was observed on the pressure gage attached to a hydrant which was not discharging. This gage showed a pressure of 54 lb. prior to opening the hydrants, and while they were discharging, a pressure of 22 lb., giving a drop of 32 lb. The recording gage on Church Street showed a pressure of 47 lb. before the test, and a pressure of 27 lb. while the hydrants were discharging. The quantity of water obtained shows an abundant supply at this point, an amount in excess of the combined capacity of the engines working at the end of the first hour. A draft from the mains equal to the previously estimated quantity pumped by the engines, namely, 2 500 gal. per minute, would cause a local drop in pressure of less than four pounds. On the date of the fire, the recording gage on Church Street showed 42-lb. pressure when the first alarm was received. In thirty minutes the pressure had dropped to 33 lb., and at the end of the

hour to 20 lb. From this record it is evident that a quantity of water approximately equal to the quantity obtained at the flow test was being withdrawn from the system and the principal object of this investigation is to account for this large rate of flow. One 8-in. and two 6-in. connections supplying the two sprinkler risks already referred to must bear the blame. The 8-in. connection from the 20-in. main was through 25 ft. of pipe to the sprinkler equipment in the Charles H. Keefe plant, and the two 6-in. connections supplying the sprinkler equipment in the Carr Leather Company's plant was fed through 200 ft. of 8-in. main connected to the 20-in. pipe. These buildings ignited immediately, and a large number of sprinkler heads opened in a very short time but were powerless to check the fire, and the collapse of the buildings resulted in the breaking of the sprinkler pipes, allowing the capacity of the three large connections to be wasted from the 20-in. main. To determine the actual effect of these three broken pipes they were opened shortly after the flow test above referred to was made, with the following result:

A gage on a hydrant on the 20-in. main showed a normal pressure of 54 lb., and when the connections were open and flowing, a pressure of 31 lb., which, from the previous flow test, enabled the discharge from these pipes to be accurately determined at 7 200 gal. per minute, a quantity of water in excess of the entire supply required for the fire protection of a city the size of Salem according to the best modern practice: the Church Street gage fell during this test from 46 lb. to 33 lb. The effect of the discharge through these connections is further shown by the recording gage, which continued to drop during the fire as increasing waste was caused by other broken pipes, by increasing demands from the engines, etc.; about 3.00 P.M. it registered 13 lb., about which time a supply at the rate of 8 000 000 gal. per day was delivered from the Peabody system without improving the pressure; at about 5 P.M., the heat had so abated that it was possible to shut the gates during these connections. When this was done the pressure immediately rose to a little over 21 lb. From the previously recited facts it is evident that the broken pipes had so depleted the supply of water that the fire department, of metropolitan size, was seriously crippled within one-half hour, and rendered

almost impotent as the fire progressed. It may be stated that during the progress of the fire, after the pressure was destroyed, two 8-in., eight 6-in., and two 4-in. pipes were discharging into broken inside equipments.

The lesson to be learned from the experience in Salem is that the existence of connections from a distribution system of such size that the quantity of water delivered through them may cripple or destroy the hydrant service is a mistake that surely invites disaster to all water-works systems, and doubly so to those depending upon hydrant hose streams. We recognize the absolute necessity of better building laws, of the general installation of sprinkler equipment, of well-manned and properly equipped fire departments, of uniformity in hydrants and hose threads, of the proper care of explosives and inflammables, of providing for effective direction of the fire fighting forces when the emergency arises, and of an adequate and reliable water supply. But this latter must be safeguarded against such failure as resulted in Salem without detracting from the service which it can safely supply to sprinkler equipments which we believe are invaluable.

The records of fires occurring in sprinkler risks during the past sixteen years show that in 13 691 cases the fire was controlled by the opening of less than 51 sprinkler heads, and in 662 cases only, or 4.6 per cent. of the total, were more sprinklers called upon to open. A 4-in. connection is sufficient to supply 51 sprinkler heads.

All standard sprinkler equipments are fitted with local alarms, and many, through supervisory service, are connected to fire alarm headquarters; in either case the fire department should be promptly notified. In most closely built-up sections, the first piece of apparatus will be on the ground within three minutes, and additional water may be immediately delivered to the sprinklers through outside Siamese connections with which all sprinkler equipments should be provided. The fire department would then have the supply of water under its control, and would be able to deliver it at the seat of the fire rather than use it with little effect as is so often done. Such a method of operation would preclude the possibility of a single large connection menacing the entire community; if any risk is of such special hazard that additional protection is necessary, this should be provided apart

from the public supply either by tanks or other storage. It must be borne in mind that the actual breaking of large connections or of pipes in the equipment connected is not necessary to bring disaster; the opening of too many sprinkler heads may be sufficient to cause serious results, and this might occur in a modern fire-proof building which would not collapse and break the equipment or connections.

Three buildings are now standing practically unharmed in the midst of the ruins in Salem, although subject to a fierce trial by fire; they constitute an object lesson in building construction which cannot be forgotten. The three connections discharging at the beginning of the Salem fire should prove an object lesson of equal force.

DISCUSSION.

Mr. Clarence Goldsmith. This question of the size of sprinkler connections appealed to Mr. McInnes and to me, for that is something with which we have both had considerable to do during the last few years. The first attempt with which I am familiar, to get any information together along this line, was made by Mr. Mulholland, of Los Angeles. He believed that there was a possibility of putting in connections so large that there was danger that the water system would be crippled, and, desiring to get all information on the subject which he could, he issued a circular letter to a large number of superintendents throughout the country, got the information together, and tabulated it. I believe that was about ten years ago. He discovered that there were some superintendents and some engineers in charge of works who appreciated the harm that might be done through these connections. Others who had not previously appreciated it, took up the question and considered it more seriously.

The rule in the city of Boston is to limit the size of such connections to 4 in., but more than one connection is allowed if the size of the building warrants. They are generally separated about 50 ft., but are connected with the equipment in the building. This is done with the hope that in case of any rupture in the equipment some of the gates can be closed. But I think that all water-works men appreciate the fact that this is a pretty

slender thread to cling to, for at the time of a fire the superintendent or foreman in charge does not feel that he has the authority to close these connections, and the chief of the fire department is generally very busy attending to other matters, and also he would be rather loath to give the order; and the result is, if the fire is a serious one, that when every one realizes the necessity of closing these connections it is impossible oftentimes to approach the building.

To give an example of the fallacy of the idea of closing the connections, I will cite a fire in the Derby Desk Company at Pittsburg, Pa., where there were two 8-in. connections entering the building. Two emergency crews fully equipped responded from the water department on the first alarm, and within twenty minutes from the time the alarm was received a heavy mass within the burning building fell and broke off both those connections, and it was over an hour before the crew was able to close both the gates. During that time the system was being severely bled, and there would have been a shortage of water except for the very strong distribution system in the city of Pittsburg, which consists of a 36-in. loop with a 12-in. gridiron. Most of our cities could not have stood such a draft.

There are numerous instances where broken connections have seriously handicapped the fire department. The last large fire in Atlanta, Ga., was another example. The fire occurred very near the center of the city, but, owing to the topography of the city, not in the center of the distribution system but on a loop which ran along a street parallel to a railroad yard. A 4-in. standpipe and another large connection failed, and there was considerable difficulty in getting water until the fire had spread to such an extent that it reached back to the larger mains.

The great difficulty at the present time is to get the fire departments educated to use the sprinkler as a part of their equipment. It is only recently that all sprinkler equipments have been required to have an outside Siamese connection for the fire department, and when it appreciates the value of the sprinkler equipment, on account of its ability to deliver water at the seat of the fire, instead of wasting a very large proportion of it, I believe the fire department will use the sprinkler equipment to

its best advantage. If they do so use it they will be able to tell from suitable pressure gages on the line the pressure which is being maintained on the equipment; and if any serious rupture has occurred they will know that it is futile to pump any more water, and they will take their lines off and proceed, as they do in the case of an unsprinklered building, to attack the fire with hose streams.

Mr. H. O. Lacount. You can overdo a good thing, there is no doubt about that, and you can put in unnecessarily large connections for the sprinkler system as well as for other services. But from the standpoint of our office, backed by a considerable experience with sprinklered risks, we think there is danger in putting in too small connections.

I haven't had an opportunity here to focus my thought particularly on this matter of the size of connections, but one or two things occurred to me while I listened to the latter part of Mr. McInnes's paper and to Mr. Goldsmith's remarks. They both referred to 4-in. connections, of which it would be permissible, according to their idea, to put in several, depending upon the amount of water which is legitimately demanded by the size of the equipment supplied. Now, those various 4-in. connections are connected inside, or brought inside the building into what you may call a header system, and if you wreck your header it looks to me as though you were going to waste as much water through several 4-in. connections as you would through one large connection passing the same point where the header system is located. Then, furthermore, an objection to small connections in multiple is that you complicate your system. You have a number of additional valves, which it is a care to maintain, and one thing which I think the sprinklered risk jurisdiction fears as much as anything is a closed valve. A closed valve on the sprinkler system is as disastrous as no connection at all, until it is opened; and, therefore, the more valves you put in, necessitated by an additional number of the smaller connections, the more you increase the chances that the valves will not be open when the emergency comes. Therefore it seems to me that a reasonably good-sized connection, — not too large, but certainly in many cases as large as 6 in., and under some conditions even larger, —

is as safe as the other and in some ways much preferable, and, therefore, I certainly would advocate in certain places connections larger than a 4-in. I think a 6-in. connection is entirely reasonable under proper conditions, and, for purposes of control, which would be desirable, I believe it is generally possible to so locate the controlling valve that, barring a conflagration when everything is driven off the street, you would be able to get at the valve in case of really serious trouble with the building. Block control by valves located at street intersections would still be available for preventing waste when local control valves could not be reached.

Mr. Goldsmith. It was not my intention to convey the idea that either I or Mr. McInnes believe in these multiple connections. I merely suggested that as the ordinary method of handling the situation in the city of Boston at the present time. I think our paper brings out the fact that we believe in having but one connection, because that will handle 95.4 per cent. of the fires, and in the cases of those that cannot be handled that way the supply can be augmented by connections by the fire department.

In dealing with this subject we have been considering only built-up areas with risks which expose other buildings, and, as I believe Mr. Lacount represents a company which to a greater or less extent is dealing with risks which are more or less isolated, many of which are of especially high hazard and require large connections, I believe in such cases it is highly desirable and permissible to give a connection that will be ample for the number of sprinklers which a fire will open. The problem is somewhat different, however, when you come to closely built-up down-town sections.

Mr. McInnes. I wish simply to supplement what Mr. Goldsmith has said, for it is evident that Mr. Lacount has misunderstood, to some extent, our position. We have given no hint in our paper that we believe in a number of 4-in. connections, and Mr. Goldsmith in stating the Boston practice does not endorse it. This practice is based on the idea that the separation of the pipes lessens the danger of complete failure from falling walls cornices, etc., and, further, that it might be possible to shut one

pipe off when another could not be reached: the principle is carried still further by taking the pipes from different sides of a building when possible.

I, personally, think our policy is a mistaken one; in closely built-up sections the rule of one pipe only, not exceeding 4 in., with outside connections to sprinkler equipment to be used by first engine responding if the fire is an inside one, is the greatest safeguard against disastrous fires.

Mr. Gorham Dana. I represent the Underwriters' Bureau of New England, and we have a great many risks in congested districts as well as in isolated districts. We believe, with Mr. Lacount, that a limit of four inches for the size of connections would be unfortunate. There are a great many large buildings in the cities where the sprinkler system cannot be properly supplied by a 4-in. pipe.

It has been mentioned that a large proportion of fires do not open more sprinklers than will be supplied by a 4-in. pipe. That is very true, but we want to take care of the remainder if we safely can. I think different cases have got to be treated more or less on their merits. In some cases it might be undesirable to put in larger than a 4-in. connection, while in other places, where the valve can be located at some distance from the building, it may be perfectly safe to put in a larger one.

It seems to me that this Salem fire presents another phase which might be considered, and that is the necessity of preventing the start of a conflagration by putting sprinklers in all buildings which are liable to cause conflagrations. This particular fire started in a very large frame building used for very hazardous processes, including celluloid working; and there is absolutely no question in my mind, nor in the minds of many others, that had that building been equipped with sprinklers there would have been no conflagration. Now, isn't that the best end to work on, — that is, to prevent the start of fires? I do not believe that any rules which anybody can make will properly take care of a conflagration. A conflagration is one of those things which, when it gets going, is beyond human ingenuity to cope with. I don't believe that additional water pressure in Salem would have helped materially, because they did not have the force to handle it. You

cannot do anything against a conflagration except by attacking the edges of the fire. One trouble in Salem was the fact that the fire department was undermanned when the fire began. They had a force, as I recall it, of about 23 men. Five of those men, I think, — I am not exactly sure of the figures, — were off duty, it was their "day off," and I think nine were at lunch, so it left less than half the normal force. That was one of the troubles. The next trouble was that when they started to fight that fire one of the chuck hydrants broke, — I think the second one they tried to use went out of commission, — and that delayed them at a very important point. If they had been properly manned and had got to the fire quick enough, they probably would never have had these broken sprinkler connections.

Another feature is the chuck hydrant. That is probably not being installed much to-day; it is rather an out-of-date device, perhaps. But still this fire brought out its undesirability very strongly, because the out-of-town departments were absolutely useless unless they could get one of those chucks, and there were not very many extra ones to be had, so that many of the out-of-town departments had to stand by and do practically nothing, because they couldn't connect with the water pipes. It seems to me that some discussion along those lines might possibly be of profit.

Mr. Dexter Brackett. The last speaker referred to the Lowry hydrant, or the hydrant used with a chuck, as being out of date or antiquated, but I well remember the first use of that pattern of hydrant in Boston, in 1869 or 1870, and at that time it was certainly a great advance over the patterns of hydrants then in use. As this pattern of hydrant is placed directly over the pipe from which it is supplied, and in many cases at the junction of two pipes, and the hydrant itself is generally 9 in. in diameter, it has a large capacity, and being located in the center of the roadway is conveniently accessible to several engines. It has the disadvantage of being hidden by snow and ice in the winter, and of requiring time for making connections between the engines and hydrant by the use of a chuck which may not be carried by engines from neighboring towns.

It occurred to me as Mr. Dana was speaking that the solution

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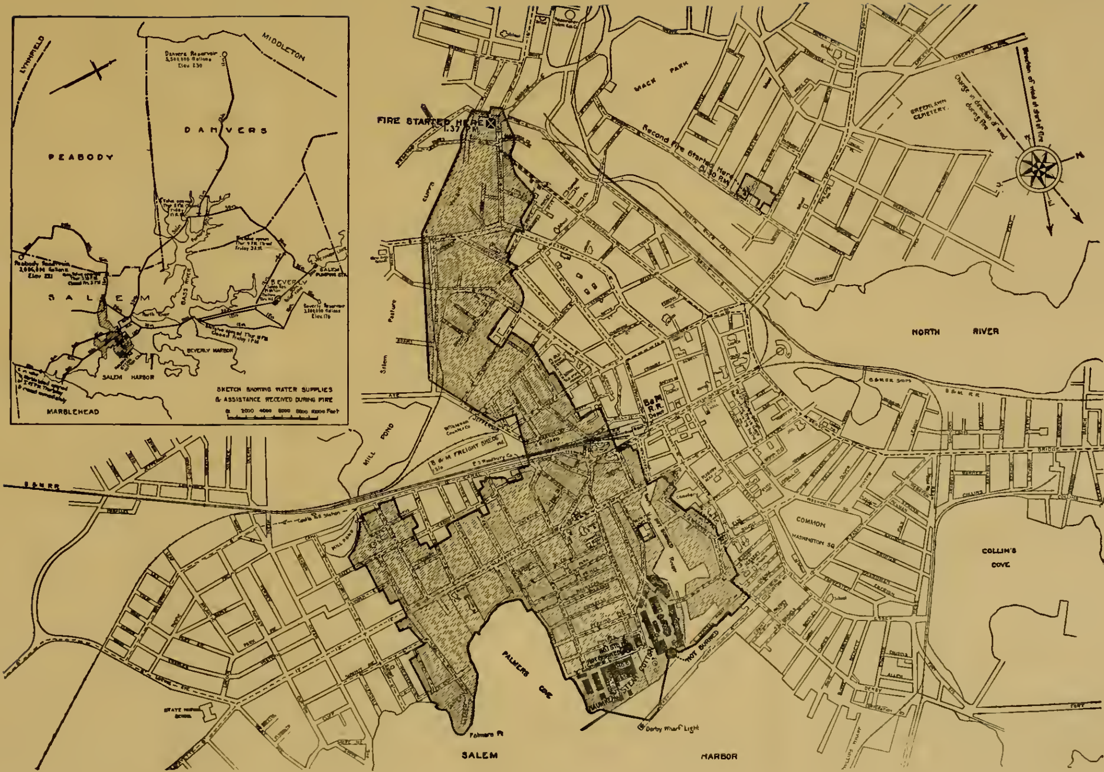
THE SALEM FIRE.



of this bugaboo of bad risks is largely in the hands of the insurance men. If they would simply refuse to insure such risks I think they could force the owners to take the proper precautions and install sprinkler systems. I have found within the last few years an amazing ignorance among owners of property as to even the existence of such a thing as a sprinkler system, and I find that when I take the matter up with them and explain it, it often results in the installation of a sprinkler system, and that they are able to save the cost of its installation in the saving in insurance within a few years. I think if that was put up to the men who own such risks, with a refusal to insure under existing conditions, it would make the introduction of the sprinkler system more general.

Mr. Dana. In reply to the last speaker, I will say that I think the insurance companies do encourage the installation of automatic sprinklers, but there is a good deal of competition in the business, and there are always companies ready to insure what other companies will not. There are a great many foreign companies doing business in this country which are anxious to get business on almost any terms, and it is pretty difficult to say that no company will insure a plant which is not in good condition.

One feature in regard to the Salem fire which occurred to me was that, so far as I know, none of the steamers lacked water; that is, there was enough water in the pipes at all times to supply the steamers. Under the conditions it seemed to me that the system held up remarkably well, — I think fully as well as would occur in the water works in most towns of the size.

Mr. R. C. P. Coggeshall. I would like to ask Mr. McInnes at what stage of the fire the cement-lined mains ruptured.

Mr. McInnes. That occurred after the fire had been subdued, and the pressure had risen to practically its normal. It was high pressure which caused the break in the main, not the low pressure.

Mr. T. H. McKenzie. As I gathered from Mr. McInnes, the large trouble in Salem was the reduction of pressure and the loss of water due to the breakage of some of the large connections with the sprinkler system in some of the large factories. The gates in pipes leading to the burnt factories not having been closed, a large amount of water ran to waste and reduced the pressure. I think he should have followed that up with some

recommendations as to the method of controlling or operating the gates which control the supply into sprinkler systems, after they cease to be of service. If there were a number of 6- or 8-in. pipes broken, it isn't strange that there was no water pressure.

Mr. McInnes. I might say that the history of this fire answers that question. The sprinklers must have been fully going within a half hour or less from the time the fire started, and the connections must have broken within, certainly, three-quarters of an hour; but it was two and a half hours later before it was possible for any human being to get to the gates and close them, on account of the heat.

Mr. Walter O. Teague. On the afternoon of the Salem conflagration, Mr. E. V. French, of the Arkwright Mutual Fire Insurance Company, and I went to the Naumkeag Steam Cotton Company mills and saw that they were prepared to make a fight if the fire came near them.

There was practically no city water pressure, but the mill firemen had the two 1 000 gal. fire pumps going taking suction from the harbor and throwing a good stream on the fire traps nearby, to wet them down.

The fire spread through the thickly built-up section to the southwest, on the windward side of the plant, and before we realized it it was down on the mill. We attempted to make a stand to resist the advance of the fire from the windward side. I would know better the next time than to do that, but it was quite the natural thing to do. But you have got to fight these conflagrations on the windward edges and not on the leeward side, because it is impossible, of course, to withstand the heat there long enough to apply the water. We found that out very quickly and in fifteen minutes we were driven back gradually and had to abandon the hose. Fortunately we were able to shut off the streams at the hydrants which were in use, as we went backwards towards the mill.

We fought there for two solid hours, and the men were practically all in and were physically unable to do much more. It developed that that didn't really count after all, for the only hope of saving the plant was the automatic sprinklers. As we gradually shut down the streams the sprinklers came into play, and as they

opened they drew down the pressure somewhat, until finally, at the height of the fire, one of the pumps failed us, the pin on the sleeve of the piston rod working loose, and the pressure dropped to 10 lb. It was put back into commission in twenty minutes, but twenty minutes at that time seemed like several hours. When we got the pump finally going again we got the pressure up to about 20 lb., and that is about as high as we could get it. It was evident that so many sprinklers had opened while the pressure was down, with only one pump running, that we could not get it back again. We then decided to close some of the gates in the yard mains to sprinkler systems in the buildings at the south end of the yard, but the fire had got into a four-story wooden mill building which was completely sprinklered, but with the low pressure the sprinklers were not effective, and in the few minutes while the pump was shut down the building burst into flame. The tremendous heat and fire from that building swept down on to the indicator posts which were some fifty feet from the building, and prevented us from getting at the valves so as to shut off these southern buildings.

In the hope of saving as much of the plant as we could, we shut the division gates, where we could get at them by shielding the man at the valve by our coats. That raised the pressure up to 120 lb., and it held there for half an hour or so and then gradually it began to go down, until we had to leave the plant at a little after ten o'clock, because the fire came into the boiler house and drove the firemen out. In half an hour the pressure had dropped to about 80 lb. That showed that even in those buildings which were quite remote from the burning district a great number of sprinklers were opening. Nevertheless, the sprinklers held the main building, which is on the bank of the river, until one o'clock in the morning, and we thought for a time that it would pull through. But finally the fire got into that, and in fifteen minutes the walls of the building began to fall.

The speed of the fire through those buildings was astonishing. They were of plank and timber construction, with brick walls and cast-iron columns, but in fifteen or twenty minutes from the start of the fire in those buildings the walls began to fall, and of course later developed into a total loss. I don't know, of course, how

long the pumps ran, but it seems as though they must have run pretty well on towards half past eleven or twelve o'clock to hold the fire back as well as they did.

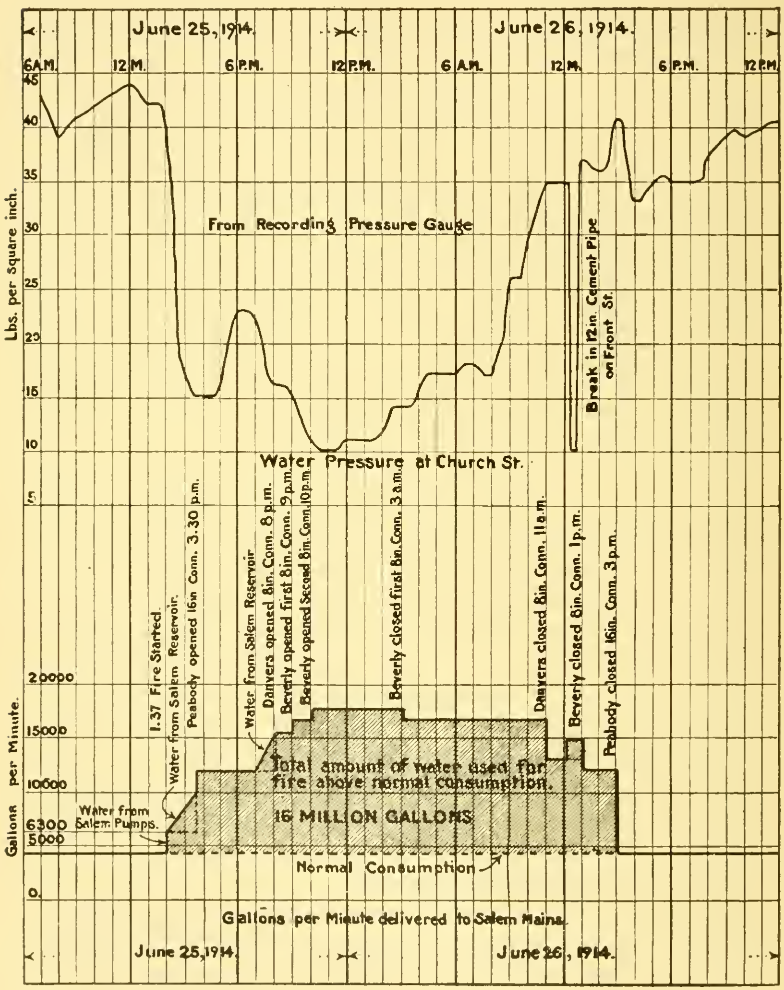


FIG. 1.

Charles H. Smith. Being of the insurance fraternity I have had opportunity to study the Salem fire and the lessons to be drawn from it. To my mind the two main features are the very poor construction of that part of Salem, especially where the fire started, and the fact that the large factory in which it started lacked automatic sprinklers. I think that if it had had them and a supply pipe of liberal size, Salem undoubtedly would be to-day where she was before the fire. There is no question but that at the start of the fire there was a 20-in. pipe in front of that building, with about 50 lb. pressure on it, and that the firemen with that water supply were unable to stop the fire when it started.

Another interesting thing to me is the fact that the speaker has recommended steamer connections to all sprinkler systems. That is something that the insurance people as a rule have tried to get for a great many years. We are meeting with some success, and in a number of the largest cities it is now the rule that the steamer connections shall be provided when sprinkler systems are installed. But it is still more or less difficult to educate the fire department up to connecting to those steamer connections, even when they exist. We will all welcome the day when the fire departments are instructed to connect the first line of hose of the first steamer to those sprinkler connections.

Another point is that I think the presence of cement-lined pipe in the Salem streets was somewhat of a deterrent to the outlying towns which had connections with the Salem service from turning their water into the Salem pipes, until they were sure that there was sufficient draft so that their higher pressure would not rupture the Salem pipe.

We made a plot of the total amount of water used during the Salem conflagration and figured that it was about 16 000 000 gal. above the normal use, from the start of the fire up to two o'clock on June 26, the next day.

Mr. McInnes. One thing that struck me very strongly during the fire, and later when looking over the ruins, was what the firemen were able to do under exceedingly adverse conditions. Before leaving one point of the fire Mr. Goldsmith and I spoke of a church and several other buildings, agreeing that they were

doomed; yet, to our surprise, we found them safe and sound the next day. The "stop" seemed a remarkable one, for we knew from our own observations that the supply of water at that point was very poor indeed. A walk along the outskirts of the fire, the following day, gave the same impression; there were many cases where it seemed marvelous that the firemen were able to make a successful stand under the conditions.

The query naturally arises, What would have been the result in Salem if the water supply had been even reasonably sufficient?

Mr. J. M. Diven. The Salem fire has certainly taught us the necessity of exercising more care in the installation of fire and other large services. It would seem as if the lesson must have been impressed upon the insurance people, so that they would realize the justness of our claims for safeguards on such services.

It is possible to locate all such services so that they can be controlled and shut off in case of necessity, that is, when it is found that they are crippling the water service. The owners of buildings naturally want the services put in in the shortest and cheapest way, and possibly the insurance interests agree with them in this, as cheap installations encourage their adoption; but the water-works people should insist on proper location of such services, and of all possible safeguards. It is always possible to so locate such services that the indicator post valve, and one should always be insisted upon, will be accessible, no matter how bad the fire is in the building supplied. For buildings located near the street line, the fire services can be run across the street with an indicator post valve at the curb line opposite the building, and a return pipe to the building. If this longer service, with its bends, is objectionable on account of friction, a larger pipe can be used. Or the tap can be made a hundred or even a thousand feet from the building, an indicator post put at the curb line opposite the tap, and the service run to the building. Such installations would be high in first cost but cheap if they saved the city from a conflagration.

Two four-inch services instead of one six-inch are all right if they are taken from different streets, or from points in a water main separated by a gate valve; otherwise they are about as great a menace as the one large service.

Mr. John C. Whitney. I would like to ask Mr. Diven if he has found it feasible to put into practice in his system what he professes.

Mr. J. M. Diven. No, sir; Troy is as lacking in regulations of this kind as it is possible for a city to be, and an attempt to pass an ordinance for the control of fire services was defeated. However, there is one proper installation, made so voluntarily by the mill owners. It has two services, separated by a valve in the main, and both provided with indicator post valves at curb opposite the building, with return pipes. Even should the walls of this building fall out, the indicator post valves could be reached, as the street is much wider than the height of the building.

Mr. Goldsmith. I would like to employ a little simile in a parallel case to delivering a large quantity of water for fire purposes.

There are a number of high buildings in most of our cities which it is impossible to serve under existing conditions on account of lack of pressure. We have several here in Boston which have to pump their water to the higher stories. I am pretty sure at the new Custom House they will have to pump water to the upper stories, and they certainly have to in most of the buildings in lower New York, and in Buffalo almost every building in the down-town section has to pump its water. If 75 lb. is to be maintained in the business district it will be necessary for a number of the buildings to pump the water. Now, take the case of the Woolworth Building, for instance; we wouldn't think for a minute of maintaining pressure enough on the city mains to supply it, and why should we endeavor to furnish water in large quantities in order to take care of these special risks, when these buildings do their own pumping and don't for an instant expect the city to deliver the water in their upper stories?

Both Mr. McInnes and I will admit that a sprinkler equipment in the building where the Salem fire originated would probably have stopped the fire at that point. But we also believe that if the system had been supplied with a 4-in. connection the same result would have been obtained; and from what we were able to see of the fire it seemed to us that if the supply had been

available in certain portions of the city where there was no supply when we went through those streets the fire could have been considerably narrowed up, although, of course, it would have covered a large area any way.

The water-works men and the men who represent the insurance companies are all working to the same end. There seem to be some few points on which we cannot agree, and one is the closing of the connections. Mr. Teague cites the case of the cloth mill, when both he and Mr. French were present, and he says it got so hot that they couldn't close the gate, — I presume it was an indicator post, because it is the custom of the Factory Mutual Companies to set indicator posts. Now, if Mr. Teague and Mr. French were not able to determine the time to shut it, how can we expect an emergency crew with a foreman to be able to determine the time to shut off a connection? I believe, from my point of view, that such arrangements must be made that we shall not have to depend upon any human effort to control the supply.

The idea of putting in long connections would apply in some cases, but in many of our large cities it would be absolutely impossible to lay the connection for any distance, and in most cases it is very difficult to get the connection indirectly from the main.

Mr. Lacount. Mr. Goldsmith suggests that a 4-in. connection would have probably been large enough for the factory where this fire started. I agree with him, provided a 4-in. connection was big enough to supply all the sprinklers on the floor where the fire started, because in this case, with the explosion of this very combustible material, no doubt the fire went through that whole story before the first sprinkler which opened could really get into operation and, therefore, this is a case where all the sprinklers for which any service connection would be laid out to-day would probably open very soon, and it is an example of where a full-sized connection would be necessary for good protection.

But it seems to me that the lesson of the Salem fire is not really one of large or small connections or of one or more small connections or of the location of gates. It seems to me the lesson

is that when you have got a conflagration on your hands you cannot stop it. The best solution of the problem is to not have a conflagration, and one of the best ways to avoid it is to build better and to guard what you build with automatic sprinklers and the ordinary means for fire protection.

It seems to me that above all these other considerations this Salem conflagration calls our attention very strongly to the necessity of better building construction. We want the protection that the sprinklers give us, we want good sized connections, we want a good water supply, but Salem needed better construction, and if it had had that, the fire would not have gone to the mills and the mills would not have been destroyed.

There is only one thing I know of, backed by some experience, that will stop a conflagration, and that is something of the nature of the Atlantic Ocean. That was sufficient for the job at Salem. I have heard the question asked, Where does a fire go to when it goes out? I will tell you where this one went; it went out to sea. I was down there and saw it go. There was fuel enough in Salem to have furnished energy sufficient to keep it moving yet. There was a lot of combustible material in Salem, and when it got under way there was nothing that could stop it, whether there was a 4-in. or an 8-in. connection and whether these were intact or broken off. They did stop it at the outskirts, but the conflagration itself burned to the sea.

Mr. Frederic P. Stearns. Mr. Chairman, nobody has had the temerity to suggest that it might be possible to use a pipe large enough to furnish all the water that the sprinklers could take, and have placed on it some automatic arrangement by which the water would be shut off when the velocity became too great. I don't think it practicable to do this, and yet I don't like to say that anything is impossible. Some of the inventors should try to do it. The subject has been brought up in the city of New York, and I think Mr. Flinn can tell us how they propose, in the case of the break of a 48-in. pipe under about 300 ft. head, to prevent the flooding or submerging of portions of Manhattan by the supply that can come through a 14-ft. tunnel.

Mr. Alfred D. Flinn. The type of valve to which Mr. Stearns refers is quite unusual. Catskill Mountain water will

be delivered into the mains under the streets of New York City through a pressure tunnel, deep in the rock, eighteen miles long. This tunnel extends from the Hill View reservoir at the northerly boundary of the city to the heart of Brooklyn. In constructing it, twenty-four shafts have been used, and of these, twenty-two will serve as connections from the tunnel to the street mains. Into these shafts one, or in some cases two, riser pipes of steel plates will be built, embedded in the concrete filling of the shaft and lined with concrete. Most of these risers are 48 in. in diameter, but a number are 72 in. At the top of each riser is a bronze "T," called a shaft cap. To each outlet flange of each shaft cap will be bolted an all-bronze gate valve, and beyond these bronze valves there will be the necessary cast-iron pipe specials, iron controlling valves, and pressure regulators. The special valve to which Mr. Stearns refers is known as a riser valve and will be placed in the riser about 100 ft. below the top of sound rock. The usual arrangement of a shaft with its riser valve, shaft cap, and chamber is shown by an accompanying illustration (Fig. 2), which also shows in some detail the design of the riser valve and shaft cap.

The riser valve, which is of the needle type, consists essentially of a bulbous enlargement of the vertical riser, a long spindle-shaped, or top-shaped, plug having vertical motion in the enlargement, and a removable seat ring at the top of the enlargement, forming a contracted throat smaller than the plug and upon which the plug, rising with the current, closes. A hydraulic cylinder within the plug and a fixed piston supported from the seat ring, together with devices for regulating discharge from the cylinder, control the closing of the valve. In the drawing, which shows a 48-in. riser valve, the plug or moving part, where in section, is rendered in solid black to differentiate it from the stationary parts which are hatched, although the material, manganese bronze, is the same in both.

The upper part of the plug encloses and is guided by a 7-in. vertical cylindrical stem or piston rod, which is cast integrally with a three-armed spider and the seat ring. The lower end of the stem carries the piston. The plug is further guided with respect to the piston by a $4\frac{1}{2}$-in. tail rod projecting from the piston

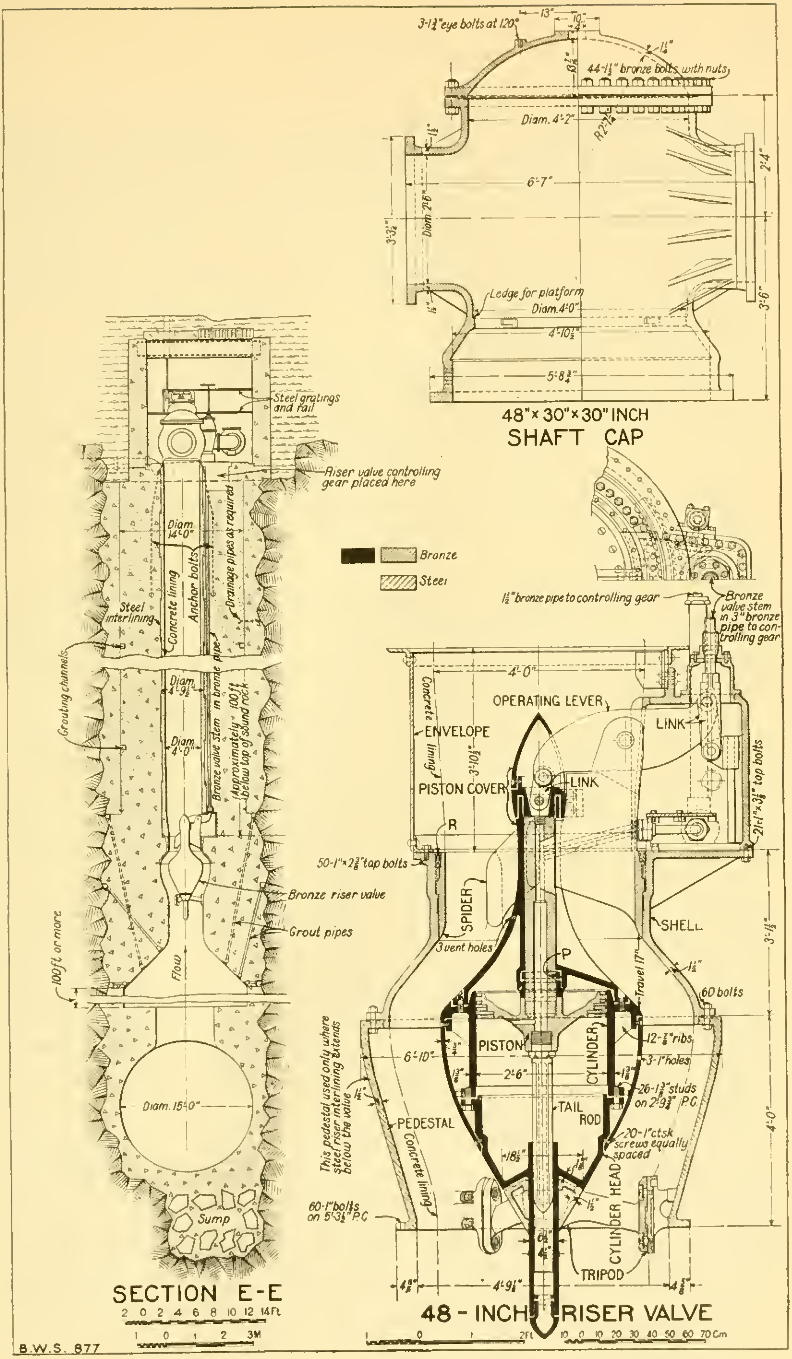

48"×30"×30" INCH
SHAFT CAP
SECTION E-E
48 - INCH RISER VALVE
Bronze
Steel
Riser valve controlling gear placed here
Steel gratings and rail
Bronze riser valve
Grout pipes
Sump
OPERATING LEVER
ENVELOPE
PISTON COVER
LINK
SPIDER
SHELL
PISTON
CYLINDER
TAIL ROD
PEDESTAL
CYLINDER HEAD
TRIPOD
This pedestal used only where steel riser interlining extends below the valve
B.W.S. 877

Fig. 2.

and sliding in a long sleeve projecting from, and formed integrally with, the cylinder head, and constituting the point of the plug. Grooves in the tail rod permit the flow of water between the cylinder and sleeve as the valve moves. The sleeve in turn slides in the hub of a fixed three-armed spider, marked "Tripod" on the drawing, forming an outside guide at the extreme lower end of the moving plug.

When the valve is in its normal or wide-open position, the plug rests on conical steady bearings at the hubs of the spider and of the tripod. These conical bearings are designed to prevent oscillation of the plug due to eddies in the flowing water and so to relieve the cylindrical guide surfaces from wear. The tripod is capable of supporting the whole weight of the removable parts of the valve above it, including the piston and spider, as well as the plug.

Ports through the piston, piston rod, and one arm of the spider establish a connection between the cylinder and a 1½-in. bronze pipe extending to the valve chamber at the shaft head. By forcing water into the cylinder through this pipe, the plug can be forced down and the valve opened; conversely, when this pipe is opened to the air the excess pressure which will exist in the riser outside the plug over that in the cylinder will force the valve to its seat. The rapidity of closing will be determined by the rate at which water is allowed to escape through the 1½-in. pipe.

An operating rod connected to the plug through a lever and links will extend from the riser valve to the valve chamber at the shaft head, affording a position indicator, an auxiliary means of operation and a partial counterbalance for the moving plug. The rod works in a bronze pipe slightly larger than the rod couplings, this pipe, like the 1½-in. pressure pipe, being embedded in the shaft concrete. A stuffing box at the top of the operating-rod pipe will prevent leakage.

The piston cover has three functions, — to connect the cylinder to the operating lever, to smooth the waterway, and to exclude grit which might otherwise reach the piston rings and cylinder and score them and cause leakage from the cylinder, and so permit too rapid closing. Since deep pockets in the piston cover are necessary under the spider arms to allow the valve to close,

and since grit might enter between piston cover and piston rod through these pockets, a packing ring, P, is provided between piston rod and piston cover below the bottom of the pockets.

Three tapped vent-holes are provided in the piston cover to permit free flow of water to or from the space between piston and piston cover as the valve moves.

The piston rings are similar in shape and action to the familiar cup-leather packings, but are made of manganese bronze about $\frac{3}{32}$ in. thick, beaten to shape, annealed dead soft, and ground on their outer circumference to a diameter slightly greater than that of the cylinder. The cylinder is carefully ground to exact and uniform diameter.

The lower three piston rings are to prevent escape of water from the cylinder when the pressure in the cylinder is being maintained to prevent too rapid closing of the valve. The upper, reversed ring is to prevent leakage into the cylinder when the pressure in the cylinder is reduced to force the closing of the valve. This reversed ring also is to act as a guard and scraper to protect the rings below. This construction has resulted in an extraordinarily small leakage past the piston, the valves when tested leaking in no case more than one gallon per hour at 600 lb. per sq. in. In each case the piston was stationary during the test. Prior tests on a 12-in. model with ground steel cylinder and one brass ring of the same construction showed substantially the same leakage whether the piston was stationary or moving.

In order that the riser might be used as a hoisting shaft, should repairs in the tunnel become necessary, it was required that all parts of the valve within the waterway should be removable. To this end the spider locks into the throat of the shell somewhat as the breechblock of a cannon locks into the breech; the detail, however, is simpler, there being only a single ring of matching lugs on the spider ring and on the shell.

Mr. Dana (*by letter*). — An inspector of the Underwriters' Bureau of New England was in Salem when the conflagration broke out, and reached the Helburn Leather Company on Goodhue Street, about 600 ft. from the fire, fifteen minutes after the alarm came in. He noted that the water pressure on their gage was 20 lb., the normal pressure being 40 to 48 lb. At that time

none of the sprinkler pipes had broken, but a few sprinklers in the Chas. F. Keefe risk had undoubtedly opened, because the water flow alarm from their system was received by the American District Telegraph Company at Peabody at 1.49, or ten minutes after the public alarm was sounded. No other buildings equipped with sprinklers had taken fire at this time. There was a 2-in. domestic-service pipe running into the Creedon Building, where the fire started, and this was probably broken early in the fire.

In this connection it is interesting to note that last winter, during a cold snap, the water pressure at City Hall dropped to 25 lb. from a normal pressure of 40 lb. on account of consumers opening their faucets enough to prevent freezing during the night. The National Board of Fire Underwriters' tests in September, 1914, with two 6-in. and one 4-in. sprinkler connections at the Keefe and Carr Leather Company's plants open, showed a drop in pressure of 23 lb., which is about the same as that caused by the opening of faucets to prevent freezing.

All this would seem to show that the loss through broken domestic-service pipes was as much if not more than that from broken sprinkler connections, and that, therefore, the breaking of sprinkler connections was not the principal cause of the drop in pressure during the conflagration.

Mr. McInnes and Mr. Goldsmith (*replying to Mr. Dana's discussion by letter*). — The authors are confident that the gage readings at the Helburn Leather Company are misleading and erroneous as indicating conditions existing on the distribution system. Our reason for this statement is the conclusive fact that the actual drop in pressure on the system at the end of the first fifteen minutes was 4 lb. as recorded on the gage of the Salem Water Department at Church Street; this drop means a draft of not more than 2 500 gal. per minute. It is evident that the gage readings given by Mr. Dana cannot represent the actual pressure on the distribution system but must be otherwise explained; for example, by incorrect gage, by local draft, etc. We agree the loss through broken service pipes to have been very serious as the fire progressed, but we positively know the loss from this cause was negligible through the first hour of the fire, the period covered by our paper and on which our argument is based.

Mr. W. S. Johnson * (*by letter*). In a discussion of the lessons to be learned from the Salem fire, it may be of interest to know some of the things which the city itself has learned. In the first place, it has learned the value of good neighbors. Water was used during the fire at a rate of 17 000 gal. per minute, and of this the city could furnish only 7 000 gal. per minute. The remainder was supplied by the neighboring cities and towns through connections which had been provided for such a contingency. Had these connections not been available, parts of the city would have been absolutely without water.

The town of Marblehead, one of the neighbors, was unable to give assistance, as the principal part of the supply for this town is pumped by electricity furnished from the power station in Salem, which was put out of commission by the fire. While Marblehead might get a partial supply from the neighboring town of Swampscott, it is certain that it would have been difficult to fight even a small fire in that town had one occurred during the Salem conflagration. The lesson as to the unreliability of electrically operated pumps is obvious.

The most important lesson which Salem has learned is the necessity of being able to deliver an ample supply of water under a proper pressure with which to fight fires. This was thoroughly realized by the officials in charge of the water department, and the city engineer had already made plans for such a supply. The water department was making a net profit of from $60 000 to $70 000 per year, but there were so many other uses for the money that the construction of the high-pressure system was postponed. The introduction of a higher pressure involved the relaying of about twenty miles of cement mains which were not capable of standing the increased pressure, as well as the construction of a new reservoir, pipe line, and pumping machinery. As a result of the fire, work on this new system is already under way, and when completed the city will itself be able to furnish as much water as was used during the fire with a sufficient pressure for hydrant streams.

While the quantity of water available was apparently sufficient to supply steamers at all times, with possibly one exception,

* Sanitary and Hydraulic Engineer, Boston, Mass.

there was not enough pressure to enable the householders to protect their roofs from sparks. With sufficient pressure the householders could have done much to prevent the spread of the fire by protecting their own roofs.

As to the sprinkler connections referred to by the authors, it is certain that the bleeding of the system through these connections and through the great number of house connections was very great, and it was impossible to get at gates to shut them off. It is doubtful, however, if smaller connections would have had any effect in preventing the spread of the conflagration, but it seems reasonably certain that more sprinkler connections would have checked it. If the factory in which the fire originated had been provided with sprinklers, it would probably have been possible to have confined the fire to that immediate vicinity.

Messrs. F. A. McInnes and Clarence Goldsmith. The authors must take exception to Mr. Johnson's statement that "the quantity of water available was apparently sufficient to supply steamers at all times with possibly one exception." Our exception is based both on personal observations during the fire and upon the testimony of many responsible firemen. The evidence is conclusive that the steamers could not obtain a sufficient supply of water during the first hour; this handicap increased as the fire progressed, and further waste was caused by breaking of other large connections and of service pipes.

PROCEEDINGS.

Annual Meeting.

Hotel Brunswick,
Boston, Mass., January 13, 1915.

The President, Frank A. McInnes, in the chair.

The following members and guests, among whom were a large number of ladies, the day being known as "Ladies' Day," were present:

Honorary Members

Desmond FitzGerald and F. P. Stearns. — 2.

Members.

R. C. Allen, S. A. Agnew, L. M. Bancroft, Dexter Brackett, E. C. Brooks, James Burnie, J. C. Chase, R. D. Chase, G. W. Cutting, Jr., J. M. Diven, John Doyle, E. D. Eldredge, G. H. Finneran, F. F. Forbes, A. S. Glover, J. M. Goodell, R. K. Hale, F. E. Hall, L. M. Hastings, A. R. Hathaway, D. A. Heffernan, D. J. Higgins, A. C. Howes, W. S. Johnson, Willard Kent, S. E. Killam, Morris Knowles, C. F. Knowlton, T. E. Lally, F. A. McInnes, Hugh McLean, J. A. McMurry, H. B. Machen, H. V. Macksey, A. E. Martin, John Mayo, F. E. Merrill, G. F. Merrill, H. A. Miller, F. L. Northrop, T. A. Peirce, J. Harold Remick, L. C. Robinson, A. T. Safford, G. A. Sampson, P. R. Sanders, Carleton Scott, C. W. Sherman, E. C. Sherman, J. Waldo Smith, G. A. Stacy, R. H. Stearns, W. F. Sullivan, C. N. Taylor, D. N. Tower, J. H. Walsh, R. S. Weston, G. C. Whipple, J. C. Whitley, F. I. Winslow. — 60.

Associates.

Builders Iron Foundry, by A. B. Coulters; Chapman Valve Mfg. Co., by J. F. Mulgrew; Darling Pump and Mfg. Co. (Ltd.), by H. A. Snyder; *Engineering Record*, by I. S. Holbrook and Burdette Phillips; Gamon Meter Co., by J. S. Eggert; Hersey Mfg. Co., by A. S. Glover and S. B. Greene; Lead Lined Iron Pipe Co., by T. E. Dwyer; Mueller Mfg. Co., by G. A. Caldwell; National Meter Co., by J. G. Lufkin and H. L. Weston; National Water Main Cleaning Co., by B. B. Hodgman; Neptune Meter Co., by H. H. Kinsey; Norwood Engineering Co., by H. N. Hosford; Pitometer Co., by E. D. Case; Pittsburgh Meter Co., by J. W. Turner; F. H. Hayes Machinery Co., by F. H. Hayes; Rensselaer Valve Co., by C. L. Brown; A. P. Smith

Mfg. Co., by D. F. O'Brien and F. L. Northrop; Standard Cast Iron Pipe and Foundry Co., by W. F. Woodburn; Thomson Meter Co., by E. M. Shedd; Union Water Meter Co., by F. E. Hall; Water Works Equipment Co., by W. H. Van Winkle, Jr.; R. D. Wood & Co., by C. R. Wood and N. M. Simmons; Henry R. Worthington, by Samuel Harrison and W. F. Bird. — 30.

Guests.

Mrs. S. C. Prescott, Mr. and Mrs. W. B. Webber, Mrs. F. F. Forbes, Brookline, Mass.; E. A. Pike, water commissioner, Groveland, Mass.; Mr. G. A. Stowers, Billerica, Mass.; Mrs. Samuel Harrison, Mrs. D. L. Dow, C. R. Hildred, Somerville, Mass.; Mrs. E. E. Martin, Mrs. C. F. Knowlton, Mrs. E. C. Brooks, Melrose, Mass.; Mrs. John Mayo, Bridgewater, Mass.; Mrs. Albert S. Glover, Mrs. Dexter Brackett, Mrs. F. I. Winslow, Mrs. F. A. McInnes, Mrs. G. A. Caldwell, Dr. and Mrs. Allan McLaughlin, H. F. Fiske, J. A. Tomasello, Boston, Mass.; Mrs. C. W. Sherman, Belmont, Mass.; Miss E. Mellen, Mrs. D. J. Higgins, Waltham, Mass.; Mrs. E. B. Hamlin, Providence, R. I.; E. P. Lane, Manchester, Mass.; Dwight L. Agnew, Scituate, Mass.; H. A. Bancroft, Reading, Mass.; J. E. Shredo, Holyoke, Mass.; Mrs. G. C. Whipple, Cambridge, Mass., and George W. Taylor, New York, N. Y. — 32.

After dinner, during the serving of which there was vocal and instrumental music, President McInnes spoke as follows:

Gentlemen will please come to order. There are no restrictions on the ladies.

First of all, a word to the ladies. In the name of our Association permit me to welcome you most heartily, and to thank you for coming through this horrible weather to be with us to-day. We acknowledge you to be superior beings, and we agree with Burns —

> "Auld nature swears, the lovely dears
> Her noblest work she classes, O:
> Her 'prentice han' she tried on man,
> An' then she made the lassies, O."

Our mistake in the past has been to try to get along too often without the inspiration of your presence. Allow me to ask you to make yourselves thoroughly at home and to enjoy the afternoon.

My next duty is to — no, it would be absurd for me to introduce the speaker. Our Association is very deeply indebted to him already, and we are fortunate indeed that he is willing to increase our obligations. I have very great pleasure in presenting Mr. Desmond FitzGerald.

Mr. Desmond FitzGerald. *Mr. President, Fellow-Members and Ladies,* — who, according to our President, were made last, that being always the order in the creation of perfect works: I wish to thank you for your very kind introduction and cordial reception. A good many years have now passed since this Association started. I had the pleasure of being present at the birth. As I look back on those days and recall the humble way in which we began, and then look around to-day and see this great Association stretching out like a great tree, with branches in every direction, I can hardly believe my own eyes. The progress of the New England Water Works Association is little short of marvelous. In the beginning, the standards for construction were in process of development and it was due largely to the interesting and instructive discussions before this body that correct practice was more or less standardized. Think for a moment how water-work systems have grown in New England and how much good they have accomplished for the health and prosperity of the people. In this work our Association has played a prominent and important part and I believe you will agree with me that we are entitled to be proud of its growth and success. [*Applause.*]

Mr. FitzGerald then proceeded to show and describe a series of colored lantern slides, the photographs from which they were made having been taken by him. There were views of scenes in this country and in England, France, Switzerland, Italy, and other European countries, and in Japan and the Philippines.

After Mr. FitzGerald had finished, before proceeding with the regular business of the meeting, the President said:

There is present this afternoon a gentleman who has come among us to take a new position of unusual trust and responsibility, — one which he is very well qualified to discharge, — and he has kindly consented to address us. I have the honor to introduce Dr. Allan J. McLaughlin, Commissioner of Health of the State of Massachusetts.

Dr. McLaughlin. *Mr. President and Ladies and Gentlemen,* — I have always been very much interested in the general subject of water. My interest in water extends back for some years, but I am almost ashamed to say how many, in view of the fact that one of your members reminded me that he had been inter-

ested in it since 1872. I said to him that that was the year in which I was born, and he was unkind enough to suggest that at that time I probably was more interested in milk than I was in water.

When I came to Massachusetts I was warned by one of my friends who said, " Above all things keep out of politics. Don't let your former political affiliations hamper you in any way in the work you have to do here." I replied to that, " My friend, I have been an officer of the United States Public Health Service for over fifteen years, and they have kept me moving about so fast that I haven't yet acquired a legal residence anywhere or had an opportunity to exercise the privilege of voting, so I don't even know what my politics are."

I am not prepared to make a speech to-day, and I do not intend to attempt to do it. I would like to say, however, that it gives me great pleasure to come in contact with the engineers and superintendents and others engaged in the water-supply problems of this country. It is a most interesting thing to note the evolution which has taken place in water-supply matters, as in public health matters, and I regard all water-works engineers and all water-works superintendents as health officers. And, ladies and gentlemen, I mean no reflection when I say that. I do not mean that I consider you to be of the old type of health officers who considered their duty done when they tacked a scarlet fever card on the wall. I have never met a poor health officer who was an engineer, and I have known some good health officers who were doctors. More than that I will not say.

I regard the evolution of water supplies as one of the most marvelous stories that could be read, if there were some one really able to put it on paper. I know that at one time the effort of the water-works engineers and of the water boards of the country was to secure a sufficient supply of water. Their next step was to secure a supply which was a good looking supply and which was not offensive to the senses. But it has given me much pleasure to note that it is the rule to-day for water boards and water engineers, especially, to consider that they have an obligation outside of those two former requirements, and that is an obligation to supply safe water. They all recognize it. No

longer are they so much interested in getting out the greatest number of British thermal units from a pound of coal, or in such problems as that, but they now realize that the primary interest of the people of this country is in getting safe water.

There was a time, some years ago, when the problem of a safe water supply was supposed to be solved by the introduction of an up-to-date filter plant, but we have about gotten away from that. We know that the mere installation of a plant does not solve the problem, but that it must be efficiently operated every day in the year. There is an unfortunate tendency still in some places to accept any type of raw water as suitable for purification, and there are filter plants in this country which are struggling with raw waters of such a character that an unreasonable responsibility is placed upon the plant. Water supplies of this type cannot be efficiently operated every day in the year; it is expecting too much. Safe water can be obtained from a filter plant under such conditions only by eternal vigilance, perfect operation, and the free use of chemicals. Plants receiving such raw water are entitled to the benefit of a fair effort to remove sufficient sewage from the water so that the burden will not be too great for the plant to bear.

I know that in Massachusetts and in New England generally the common type of supply is obtained by impounding upland sources and depending upon storage largely as a factor of safety. We all know that that is perfectly safe, provided you have real storage; but I cannot resist the temptation to make this point: That, if you are depending upon storage for the furnishing of safe water, be sure that you get storage. That is a perfectly safe method of water purification, provided the storage is long enough. But there are two things to consider: First, do you get storage for a sufficient number of days to permit the death of the pathogenic organisms which inevitably get into a water supply from an inhabitated surface? And, next, does the position of your inflow and outflow pipes guarantee that your storage is effective? There are some reservoirs built in such a way that sometimes the water goes through from the intake to the outflow pipe without getting the benefit of storage in the reservoir. I have no doubt you have all had experience with just such conditions.

I feel that as a measure of public health there is probably no other single agency that has the potentiality for danger that unsafe water has; and, perhaps, there is no other single measure that has effected so much in the saving of human life in this country as a safe water supply.

The meeting then proceeding with the regular order of business, the Secretary presented the following applications for membership, properly endorsed and recommended by the Executive Committee:

Resident. — P. J. Conlon, North Adams, Mass., superintendent water works, North Adams; Charles R. Gow, West Roxbury, Mass., contractor for public works; Dwight L. Agnew, North Scituate, Mass., assistant superintendent, Scituate Water Company; Harvey A. Bancroft, Reading, Mass., water commissioner; Clarence M. Blair, New Haven, Conn., civil engineer.

Non-Resident. — Frank H. Stephenson, Cleveland, Ohio, superintendent Cleveland water works.

On motion of Mr. Chase, the Secretary was instructed to cast the ballot of the Association in favor of the applicants named, and he having done so they were declared duly elected members of the Association.

The Secretary, Mr. Willard Kent, presented his annual report, as follows:

Report of the Secretary.

January 1, 1915.

Mr. President and Gentlemen of the New England Water Works Association, — The Secretary submits herewith the following report of the changes in membership during the past year, and the general condition of the Association.

The present membership is 847, constituted as follows: 11 Honorary, 766 Active, and 70 Associate members. That of one year ago was 758, comprised of 12 Honorary, 686 Active, and 60 Associate members. A net gain for the year of 89. The detailed changes are as follows:

MEMBERSHIP.

January 1, 1914.	Honorary Members	12	
	Deceased	1	
		——	11

January 1, 1914.	Total Members		686		
	Withdrawals:				
	Resigned	21			
	Dropped	34			
	Died	5	60		
		——	——	626	
	Initiations:				
	January	7			
	February	1			
	March	3			
	April	12			
	June	4			
	September	40			
	November	19			
	December	17			
		——	103		
	Reinstated:				
	Members dropped in '02	2			
	,, ,, ,, '05	1			
	,, ,, ,, '11	3			
	,, ,, ,, '13	1			
	,, ,, ,, '14	27			
	,, resigned in '04	1			
	,, ,, ,, '08	1			
	,, ,, ,, '14	1	37	140	
		——	——	——	766
January 1, 1914.	Total Associates		60		
	Withdrawals:				
	Dropped	2			
	Resigned	5	7		
		——	——	53	
	Initiations:				
	June	1			
	September	12			
	November	3			
		——	16		
	Reinstated:				
	Dropped in 1914		1	17	
			——	——	70
					——
January 1, 1915.	Total membership				847
January 1, 1914.	Total membership				758
					——
Net gain					89

The Secretary has received and paid to the Treasurer, $7 469.64.

Of this amount the

Receipts for initiation fees were			$619.00
From dues of members	$2 121.00		
From dues of members, fractional	78.00		
From dues of members, past	18.00		
		$2 217.00	
From dues of Associates	$790.00		
From dues of Associates, fractional	106.25	896.25	
Total from dues			3 113.25
From advertising			1 988.25
From subscriptions			243.00
From JOURNALS			214.44
From sundries			1 291.70
Total as above			$7 469.64

There is due the Association at this date:

For advertising	$113.75
For JOURNALS	47.00
For reprints	17.10
Total amount due	$177.85

The outstanding bills against the Association amount to $104.95.

Respectfully submitted,

WILLARD KENT, *Secretary.*

NEW ENGLAND WATER WORKS ASSOCIATION.

Year	President.	Membership at End of Year.				Annual Convention.		Receipts.	Expenditures.	Cash Balance.
		Members.	Associate.	Honorary.	Total.	Place.	Date.			
1882	(Organized)	27	—	—	27	Boston, Mass.	June 21, '82			
1882–3	*James W. Lyon	37	6	—	43	Worcester, Mass.	June 21, '83	$245.00	$87.86	$157.14
1883–4	Frank E. Hall	48	9	—	57	Lowell, Mass.	June 19–20, '84	156.14	171.90	141.38
1884–5	*George A. Ellis	83	44	—	127	Springfield, Mass.	June 18–19, '85	651.84	511.44	281.78
1885–6	R. C. P. Coggeshall	106	47	—	153	New Bedford, Mass.	June 16–18, '86	1 658.50	1 643.42	296.86
1886–7	*Henry W. Rogers	137	52	2	191	Manchester, N. H.	June 15–17, '87	1 342.28	1 066.98	572.16
1887–8	*Edwin Darling	181	54	3	238	Providence, R. I.	June 13–15, '88	2 013.30	1 697.15	888.31
1888–9	*Hiram Nevons	209	64	4	277	Fall River, Mass.	June 12–14, '89	2 204.07	2 127.70	964.68
1889–90	Dexter Brackett	257	73	5	335	Portland, Me.	June 11–13, '90	2 511.27	2 346.65	1 129.30
1890–1	*Albert F. Noyes	281	74	5	360	Hartford, Conn.	June 10–12, '91	3 055.13	1 884.78	2 299.65
1891–2	*Horace G. Holden	290	70	5	365	Holyoke, Mass.	June 8–10, '92	2 887.17	3 278.54	1 908.28
1892–3	*George F. Chace	338	69	5	412	Worcester, Mass.	June 14–16, '93	3 422.61	3 317.22	2 013.67
1893–4	*Geo. E. Batchelder	365	73	5	443	Boston, Mass.	June 14–16, '94	3 208.85	3 259.07	1 963.45
1894–5	George A. Stacy	401	81	5	487	Burlington, Vt.	Sept. 11–13, '95	3 147.41	3 115.99	2 673.03
1895–6	Desmond FitzGerald	442	82	5	529	Lynn, Mass.	June 10–12, '96	3 179.91	3 148.49	2 704.45
1896–7	*John C. Haskell	464	80	5	549	Newport, R. I.	Sept. 8–10, '97	3 340.23	3 322.94	2 271.74
1897–8	Willard Kent	488	77	5	570	Portsmouth, N. H.	Sept. 14–16, '98	3 002.13	2 786.95	2 936.92
1898–9	Fayette F. Forbes	494	73	5	572	Syracuse, N. Y.	Sept. 13–15, '99	2 825.71	3 050.23	2 712.40
1899–1900	Byron I. Cook	519	70	5	594	Rutland, Vt.	Sept. 19–20, '00	4 920.49	5 524.65	2 108.24
1901	Frank H. Crandall	493	58	4	555	Portland, Me.	Sept. 18–20, '01	4 238.55	4 283.22	2 063.57
1902	Frank E. Merrill	522	60	5	587	Boston, Mass.	Sept. 10–12, '02	5 158.48	4 680.32	2 541.73
1903	*Charles K. Walker	520	55	3	586	Montreal, Canada	Sept. 9–11, '03	5 032.40	4 505.08	3 069.05
1904	Edwin C. Brooks	538	58	8	604	Holyoke, Mass.	Sept. 14–16, '04	5 328.31	5 528.21	2 869.15
1905	George Bowers	584	53	8	645	New York, N. Y.	Sept. 13–16, '05	5 431.16	5 411.58	2 888.73
1906	Wm. T. Sedgwick	618	51	15	684	White Mts., N. H.	Sept. 12–14, '06	5 366.94	4 845.14	3 410.53
1907	John C. Whitney	636	51	15	692	Springfield, Mass.	Sept. 11–13, '07	5 291.83	†4 222.06	4 480.30
1908	Alfred E. Martin	633	49	14	696	Atlantic City, N. J.	Sept. 23–25, '08	5 706.36	7 475.56	‡2 711.10
1909	Robert J. Thomas	647	55	13	715	New York, N. Y.	Sept. 8–10, '09	5 305.31	†4 566.84	‡3 449.57
1910	George A. King	678	56	13	747	Rochester, N. Y.	Sept. 21–23, '10	6 507.08	†7 237.60	‡2 719.05
1911	Allen Hazen	680	58	12	750	Gloucester, Mass.	Sept. 13–15, '11	6 440.90	†6 279.72	‡2 880.23
1912	Geo. W. Batchelder	666	53	12	731	Washington, D. C.	Sept. 18–20, '12	6 861.65	†5 934.56	‡3 807.32
1913	J. Waldo Smith	686	60	12	758	Philadelphia, Pa.	Sept. 10–12, '13	6 122.81	†6 533.62	‡3 396.51
1914	Frank A. McInnes	766	70	11	847	Boston, Mass.	Sept. 9–11, '14	7 686.17	†7 437.17	‡3 645.51

*Deceased. † Not including December JOURNAL and Reprints. Does not include $1 815 invested in bonds.

On motion the report was accepted.

The Treasurer, Mr. Lewis M. Bancroft, submitted the following report, which on motion of Mr. Sherman was accepted and ordered to be placed on file.

CLASSIFICATION OF RECEIPTS AND EXPENDITURES.

Receipts.

Dividends and interest		$221.23
Initiation fees	$619.00	
Dues	3 113.25	
Total received from members		3 732.25
JOURNAL:		
Advertisements	$1 988.25	
Subscriptions	243.00	
Sale of JOURNALS	214.44	
Sale of Reprints	100.35	
Total received from JOURNAL		2 546.04
Miscellaneous receipts:		
Sale of "Pipe Specifications"	$42.80	
Dinners	1 035.00	
Certificates of membership	99.00	
Buttons, etc.	9.85	
Total miscellaneous receipts		1 186.65
Total receipts		$7 686.17

Expenditures.

JOURNAL:		
Advertising agent, commission	$239.00	
Plates	141.57	
Printing	2 019.03	
Editor's salary	300.00	
Expense	42.77	
Reporting	280.45	
Advance reports	90.00	
Reprints	253.00	
Envelopes	35.15	
		$3 400.97

LEWIS M. BANCROFT, *Treasurer*,
In account with the New England Water Works Association.

RECEIPTS.

1914.		
Jan. 1.	Balance on hand	$3 396.51
	Received of Willard Kent, Secretary	7 469.64
	Interest on bonds and deposits	216.53
		$11 082.68

EXPENDITURES.

Bills paid		$7 437.17
BALANCE ON HAND.		
People's Savings Bank	$2 000.00	
Mechanics Savings Bank	1 098.60	
First National Bank	529.90	
Liberty Trust Co.	17.01	
		3 645.51
		$11 082.68

ASSETS AND LIABILITIES.

ASSETS.

Cash, balance in banks		$3 645.51
Bonds Nos. 2642 and 2644, Lake Shore & Mich. So. R. R. 4%, due May 1, 1931. Book value, $1 815. Market value		1 800.00
Accounts receivable:		
JOURNALS	$47.00	
Advertising	113.75	
Reprints	17.10	
		177.85
		$5 623.36

LIABILITIES.

Accounts payable:	
Rent	$100.00
Blue prints	4.95
	$104.95
Surplus	5 518.41
	$5 623.36

READING, January 11, 1915.

LEWIS M. BANCROFT, *Treasurer*.

Office:			
Secretary, salary		$200.00	
Expense		50.50	
Assistant Secretary, salary		600.00	
Expense		194.10	
Rent		400.00	
Printing, stationery, and postage		221.75	
Membership lists		202.00	
Miscellaneous		17.61	
			$1 885.96
Meetings and Committees:			
Stereopticon		$40.00	
Dinners	$1 020.50		
Cigars	58.00		
Music	109.60		
		1 188.10	
Printing, stationery, and postage		579.58	
Miscellaneous		32.31	
Negatives		35.70	
Street railway, June meeting		25.00	
			1 900.69
Treasurer's salary and bond			67.50
Library Index			29.30
Certificates of membership			125.25
Printing "Pipe Specifications"			27.50
			$7 437.17

The Editor, Mr. Richard K. Hale, submitted the following report:

Report of the Editor.

Boston, January 13, 1915.

To the New England Water Works Association. — I present the following report for the Journal of the New England Water Works Association for the year 1914.

The accompanying tabulated statements show in detail the amount of material in the Journal; the receipts and expenditures on account of the Journal for the past year (including the cost of the December Journal and reprints, bills for which were received too late to pay in 1914, and which are consequently not included in the Treasurer's statement); and a comparison with the conditions of preceding years.

Size of Volume. — The volume is somewhat larger than in previous years.

Illustrations. — The total cost of illustrations for the year, including printing, has been $221.87, or 6.6 per cent. of the gross cost of the volume.

Reprints. — The usual fifty reprints of papers have been furnished to authors without charge, and additional reprints, when desired, at the cost of the paper and press work. The net cost to the Association for reprints has been $155.65. There have been advance copies of eight papers prepared during the year, at a cost of $108.00.

Circulation. — The present circulation of the JOURNAL is:

Members, all grades	847
Subscribers	78
Exchanges	26
Total	951

an increase of 93 over the preceding year. JOURNALS have also been sent to 40 advertisers.

Advertisements. — There has been an average of 25 pages of paid advertising, with an income of $1 694, a slight increase over last year.

Pipe Specifications. — During the year the specifications for cast-iron pipe to the value of $42.80 have been sold; 500 were printed at a cost of $27.50. The net gain up to a year ago had been $258.75, so that the total net gain from this source to date is $274.05. There are still about 438 copies of specifications on hand, or about $44.00 worth if sold at retail.

The Association has a credit of $0.61 at the Boston Post-Office, being the balance of the money deposited for payment of postage upon the JOURNAL at pound rates.

There are no outstanding bills, on account of the JOURNAL, which are not included in these tables.

Respectfully submitted,

RICHARD K. HALE, *Editor.*

TABLE No. 1.

Statement of Material in Volume XXVIII, Journal of the New England Water Works Association, 1914.

Number.	Date.	Pages of Papers.	Proceedings.	Total Text.	Index.	Advertisements.	Cover and Contents.	Inset Plates.	Total.	Total Cuts.
1	March	77	35	112	—	29	4	3	148	10
2	June	79	7	86	—	30	4	—	120	11
3	September	140	18	158	—	30	4	—	192	13
4	December	199	9	208	7	30	4	10	259	21
	Total	495	69	564	7	119	16	13	719	55

TABLE No. 2.

Receipts and Expenditures on Account of Volume XXVIII, Journal of the New England Water Works Association, 1914.

Receipts.		*Expenditures.*	
Advertisements	$1 693.75	Printing Journal	$1 987.64
Sale of Journal	214.44	Printing illustrations	85.00
Sale of reprints	39.35	Preparing illustrations	136.81
Subscriptions	243.00	Editor's salary	300.00
		Editor's incidentals	44.17
	$2 190.54	Advertising agent's commissions	235.05
Net cost of Journal	1 155.33	Reporting	254.20
		Reprints	195.00
		Advance copies	108.00
	$3 345.87		$3 345.87

TABLE No. 3.

Comparison between Volumes XIX to XXVIII, Inclusive, Journal of the New England Water Works Association.

	Vol. XIX. 1905.	Vol. XX. 1906.	Vol. XXI. 1907.	Vol. XXII. 1908.	Vol. XXIII. 1909.	Vol. XXIV. 1910.	Vol. XXV. 1911.	Vol. XXVI. 1912.	Vol. XXVII. 1913.	Vol. XXVIII. 1914.
Average edition (copies printed)	900	900	1 085	1 000	1 000	1 150	1 000	1 000	1 000	1 050
Average membership	625	665	693	699	710	732	752	740	745	803
Circulation at end of year	705	767	785	780	802	827	840	826	858	951
Pages of text	587	495	500	500	459	643	475	401	554	564
Pages of text per 1 000 members	939	745	722	715	646	880	632	542	746	702
Total pages, all kinds	784	662	669	681	627	808	654	567	733	719
Total pages per 1 000 members	1 254	995	964	976	884	1 090	870	766	984	895
Gross Cost:										
Total	$3 266.65	$2 573.61	$2 643.42	$2 733.61	$3 111.15	$3 490.81	$2 625.87	$2 476.55	$3 586.29	$3 345.87
Per page	4.17	3.88	3.95	4.01	4.97	4.32	4.02	4.37	4.89	4.65
Per member	5.23	3.87	3.82	3.91	4.39	4.78	3.50	3.35	4.81	4.17
Per member per 1 000 pages	6.67	5.85	5.70	5.88	7.00	5.90	4.09	5.90	6.46	5.80
Per member per 1 000 pp. text	8.91	7.81	7.62	8.02	9.56	7.44	7.36	8.35	8.68	7.39
Net Cost										
Total	$1 072.95	$387.96	$483.15	$131.06	$789.98	$1 334.06	$352.82	$98.81	$1 322.90	$1 155.33
Per page	1.37	.58	.72	.19	1.26	1.65	.54	.17	1.80	1.61
Per member	1.72	.58	.70	.19	1.11	1.82	.47	.13	1.78	1.44
Per member per 1 000 pages	2.20	.88	1.04	.28	1.78	2.25	.55	.23	2.42	2.00
Per member per 1 000 pp. text	2.93	1.18	1.39	.39	2.43	2.83	.98	.33	2.38	2.55

The report was accepted.

The Auditing Committee submitted the following report:

BOSTON, MASS., January 11, 1915.

We have examined the accounts of the Secretary and Treasurer of the New England Water Works Association, and find the books correctly kept and the various expenditures of the past year supported by duly approved vouchers.

Respectfully submitted,

GEORGE H. FINNERAN,
FREDERICK W. GOW,
A. R. HATHAWAY,
Auditing Committee.

On motion of Mr. Sherman, the report of the Auditing Committee was accepted.

Professor George C. Whipple, chairman of the Committee on Filter Statistics, reported that the committee had finished its labors and made its report, which was before the Association. As this was not the time to discuss it, he suggested that it be laid over until the February meeting of the Association, and on motion such action was taken.

Mr. McInnes, the retiring President, then read his annual address.

PRESIDENT'S ADDRESS.

It is difficult to realize that one year has elapsed since my duties as President of this Association began. Thomas Campbell, in inimitable verse, says, "The more we live, more brief appear our life's succeeding stages." This statement of fact does not, however, fully account for the rush with which the past year has become history, and it is gratifying, at least to assume, that the apparent speed of Father Time has been due to the activity and vitality of our Association.

Somewhat of fear and trembling possessed me at the outset; fear that my inexperience would prove a serious handicap, and trembling, on general principles, at I knew not what. I can now say — What a fool one mortal was! — and why? — simply because he did not fully realize the meaning of the magic word

"coöperation," despite the fact that our last President had, in his annual address, so convincingly and forcibly called attention to the possibilities of "working together." As a matter of fact, the hearty coöperation of our members, — officers, privates, and associates alike, — has made my path an easy one and has caused whatever measure of success has been attained.

In the reports of the Secretary, Treasurer, and Editor, which have been read this afternoon, you have heard the story of our affairs in detail for the year. The Treasurer has been good enough to show a balance on the right side of the ledger. The net gain in membership of 89, in this year of hard times when business depression is widespread and the dogs of war are loose, is the largest in the history of our Association; it is due to the splendid coöperation of which I have spoken.

Six regular meetings were held, each being well attended and of normal interest. I am convinced that these meetings can be made of still greater value to our members. A strict censorship should be exercised over the papers which are presented, to correct the condition we have all witnessed of inattention of a portion of the audience. Many papers can be read verbatim to advantage; others, often of the greatest value, should be presented in abstract form with those portions omitted which are not of direct interest to the audience as a whole, and which must be carefully read and studied at a later date in our Journal if their full value is to be realized. In this way the opportunity of meeting and questioning the author would be afforded and the purposes of full and free discussion would still be served.

Another desirable feature at our meetings is, that at least a portion of the time be devoted to the subjects in which our active members are directly interested and with which they have to do in their every-day work, to the end that the experience gained from the methods, successes, failures, difficulties, etc., of each one of us may be available for all. This give-and-take spirit of helping each other must be strongly in evidence if our meetings are to be of maximum benefit and interest.

I realize that a large majority of members are unable to attend the regular meetings, and appreciate the fact that the character of the papers and reports which are published in the Journal,

many of them classics in their field, has proved a large factor in the present prestige and success of our Association; this high standard of the past must be and will be maintained, for the willingness of our members to give of their ability and of their store of knowledge is, at least, as strong as ever.

The best traditions of our Association have been maintained in the work of our committees; at the November meeting the report of the Committee on Standard Specifications for Hydrants was considered and adopted with the exception of two requirements which were referred back to the committee for further consideration. At the annual convention three notable reports were presented, as follows: On Low Yields of Catchment Areas in New England, F. P. Stearns, chairman; on Statistics of Filter Operations, George C. Whipple, chairman; on Meter Rates, Allen Hazen, chairman.

In June, thanks to a very efficient committee, a most enjoyable outing was held at Worcester; an interesting trip over the new supply works of the city being followed by dinner on a tiny and picturesque island in Lake Quinsigamond. Such an outing, in the early summer, with the ladies participating, does much to promote good-fellowship.

The annual convention at the Copley-Plaza Hotel in this city was successful; the attendance, at least, surpassing all previous records; the Association is deeply indebted to the committees in charge.

The convention is a most effective means of furthering the interests of our Association; to be successful, in this age in which we live, suitable entertainment must be provided, at least for the ladies in attendance; the question of how the funds necessary for this purpose shall be obtained must be solved in a permanent way.

Perpetual motion has not yet been discovered; force is still required to produce results, and our Association must receive the active, continuous support of its officers and members alike if it is to be of the greatest service and is to consistently grow in strength. We must have scholarly, able, and adequate papers; interesting and practical discussions; committee reports strong enough to guide us in the right channels; good-fellowship, and

an abounding faith in our Association. We must not live in the past but, realizing that conditions and customs surrounding us are ever changing, must move, with conservative steps, in the vanguard.

Mr. Thomas E. Lally submitted the following report of tellers appointed to canvass ballots for the officers for the coming year.

ELECTION OF OFFICERS.

Whole number of ballots	353
Blank	None

President.

LEONARD METCALF	342
Scattering	1

Vice-President.

JAMES BURNIE	337
CARLETON E. DAVIS	341
GEORGE F. MERRILL	336
CALEB M. SAVILLE	338
CHARLES W. SHERMAN	342
WILLIAM F. SULLIVAN	342
Scattering	1

Secretary.

WILLARD KENT	346
Scattering	1

Treasurer.

LEWIS M. BANCROFT	345

Editor.

RICHARD K. HALE	346

Advertising Agent.

GEORGE A. KING	345
Scattering	1

Additional Members of Executive Committee.

EDWIN C. BROOKS	336
SAMUEL E. KILLAM	337
GEORGE W. BATCHELDER	340

Finance Committee.

A. R. Hathaway	339
George H. Finneran	337
Albert L. Sawyer	341
Scattering	1

Respectfully submitted,

THOMAS E. LALLY.
LEWIS D. THORPE.

On motion of Mr. Sherman it was voted to adjourn.

Hotel Brunswick,
Boston, Mass., February 10, 1915.

Vice-President William F. Sullivan in the chair.
The following members and guests were present:

Honorary Members.

Frederic P. Stearns. — 1

Members.

D. L. Agnew, L. M. Bancroft, G. W. Batchelder, A. E. Blackmer, J. W. Blackmer, George Bowers, E. C. Brooks, J. M. Caird, G. A. Carpenter, J. C. Chase, R. C. P. Coggeshall, R. D. Chase, F. L. Clapp, H. W. Clark, J. E. Conley, A. W. Cuddeback, H. C. Crowell, F. W. Dean, J. M. Diven, E. D. Eldredge, G. F. Evans, A. A. Fobes, G. W. Fuller, H. T. Gidley, Patrick Gear, F. J. Gifford, A. S. Glover, J. M. Goodell, X. H. Goodnough, F. H. Gunther, R. A. Hale, R. K. Hale, F. E. Hall, J. O. Hall, A. R. Hathaway, T. G. Hazard, Jr., Allen Hazen, D. A. Heffernan, D. J. Higgins, J. L. Howard, A. C. Howes, W. S. Johnson, Willard Kent, S. E. Killam, G. A. King, J. J. Kirkpatrick, E. E. Lochridge, P. J. Lucey, Hugh McLean, A. E. Martin, H. W. McMahon, John Mayo, G. F. Merrill, H. A. Miller, A. S. Negus, F. L. Northrop, T. A. Peirce, L. C. Robinson, G. A. Sampson, P. R. Sanders, A. L. Sawyer, W. P. Schwabe, J. E. Sheldon, Carleton Scott, C. W. Sherman, M. A. Sinclair, G. H. Snell, G. T. Staples, W. F. Sullivan, H. A. Symonds, W. C. Tannatt, Jr., C. N. Taylor, R. J. Thomas, J. L. Tighe, A. H. Tillson, E. J. Titcomb, D. N. Tower, W. J. Turnbull, Ernest Wadsworth, R. S. Weston, G. C. Whipple, F. B. Wilkins, L. C. Wright. — 83.

Associates.

Builders Foundry Company, by F. N. Connet and A. B. Coulters; Chapman Valve Manufacturing Company, by J. F. Mulgrew and J. J. Hartigan; Darling Pump and Manufacturing Company (Ltd.), by H. A. Snyder; Gamon

Meter Company, by J. S. Eggert; Hayes Machinery Company, by F. H. Hayes; Hersey Manufacturing Company, by A. S. Glover, W. A. Hersey, and S. B. Greene; Lead Lined Iron Pipe Company, by T. E. Dwyer; Ludlow Valve Manufacturing Company, by A. R. Taylor; G. A. Miller; H. Mueller Manufacturing Company, by G. A. Caldwell; National Meter Company, by J. G. Lufkin and H. L. Weston; Neptune Meter Company by R. D. Wertz and H. H. Kinsey; Norwood Engineering Company by H. W. Hosford; Pittsburgh Meter Company, by J. W. Turner; MacBee Cement Lined Pipe Company, by J. D. MacBride; Rensselaer Valve Company, by C. L. Brown; A. P. Smith Manufacturing Company, by F. L. Northrop; Thomson Meter Company, by S. D. Higley and E. M. Shedd; Union Water Meter Company, by F. E. Hall; Water Works Equipment Company, by W. H. VanWinkle; R. D. Wood & Co., by H. M. Simmons; Henry R. Worthington, by Samuel Harrison, E. P. Howard, and W. T. Bird. — 31.

GUESTS.

DeWitt C. Webb, F. M. Bates, H. C. Bond, Boston, Mass.; G. F. Goldthwait, Beverly; G. E. Hildreth, Manchester; G. H. Hiller, Hyde Park; W. F. Howland, South Framingham; H. J. Goodale, Attleboro; F. M. Sears, Northampton; E. S. Russell, Middleboro, Mass.; B. E. Warren, Nashua, N. H.; H. A. Rowell, Concord, N. H.; Edward W. Shedd, Providence, R. I.; E. S. Locke, Lexington, Mass. — 14.

The Secretary presented the following applications for membership, properly endorsed and recommended by the Executive Committee: John E. Howland, Vineyard Haven, Mass., machinist, manufacturing photographic apparatus; Carl P. Birkinbine, Philadelphia, Pa., investigations, reports, and construction of water supply and water power, dam design, water waste; Stuart A. Nims, Concord, N. H., engineer for New Hampshire Public Service Commission; Edward W. Shedd, East Providence, R. I., civil, sanitary, and hydraulic engineer; H. J. Goodale, Attleboro, Mass., assistant engineer Board of Public Works, Pittsfield, superintendent public works, Attleboro, Mass.

On motion, the Secretary was directed to cast the ballot of the Association in favor of the applicants, and he having done so they were declared duly elected members of the Association.

The Secretary read a communication from Mr. George T. Staples, as follows:

DEDHAM, MASS., February 2, 1915.

EXECUTIVE COMMITTEE,
NEW ENGLAND WATER WORKS ASSOCIATION:

Gentlemen, — In looking over the list of members, I find that Mr. R. W. Bagnell, Mr. R. C. P. Coggeshall, Mr. Albert S. Glover, and Mr. Frank E. Hall have been members of the New England Water Works Association since June 21, 1882, — charter members probably.

If it meets with your approval, I would make a motion that they be made honorary members and added to the Executive Committee.

Yours truly,

GEORGE T. STAPLES.

THE SECRETARY. This letter, so far as making the parties named honorary members, has been considered by the Executive Committee and they recommend to the Association that such action be taken.

THE CHAIRMAN. The letter is self-explanatory, evidently showing that we have a quartet of charter members still on full membership roll.

MR. R. C. P. COGGESHALL. Mr. President, I do not understand what all this means. I don't want my obituary notice written quite yet. It is pleasant to know that my friends think of me once in a while, but I am getting along pretty comfortably just as it is.

MR. FRANK E. HALL. Mr. President, I endorse everything that Mr. Coggeshall has said.

MR. FREDERIC P. STEARNS. Mr. President, in regard to writing an obituary, I can say, as one of the men who has been made an honorary member of this Society, that they are still allowed to do some work. I move that the recommendation of Mr. Staples be adopted.

MR. C. W. SHERMAN. Mr. President, I believe that any election to membership has to be made by ballot, and if Mr. Stearns will allow me, I would like to amend his motion to the effect that the Secretary be instructed to cast the ballot of the Association for these four gentlemen named in Mr. Staples's letter and that the vote on this motion be taken by a rising vote. [Adopted, the the members all rising.]

MR. COGGESHALL. Mr. President, do I understand that that was announced as carried?

The Chairman. It is carried, and I declare those four gentlemen elected honorary members of the New England Water Works Association.

Mr. Coggeshall. Gentlemen, I feel funny. This is very gratifying. I am pleased and I am delighted to know that there are so many kindly feelings towards me. I well remember the day in February of 1882 when Mr. Hall and myself went to Bob Thomas's home at Lowell, and in the Merrimac House of that city we suggested the formation of a little club to meet once a month, perhaps in Boston, during the winter months, and discuss water-works matters. But we never dreamed of an association of eight hundred members. It has gone so far beyond our expectation that sometimes I am bewildered when I look back and see that day. It reminds me that I am getting along in years. I suppose that a great many of you regard me as an old man, but I want to tell you that I am coming here for the next twenty-five years. I want to heartily thank you, gentlemen. I do, from the bottom of my heart.

The Chairman. You might have noticed that in his letter Mr. Staples asked that these gentlemen be added to the Executive Committee. As that would require a notice to the members and a change in our by-laws, the Executive Committee thought better to drop that portion of it.

Mr. F. H. Hayes. Mr. President, this is a paper that I would like to bring before this Association. It will tell what it is as I read it:

"What I have to say at this time is a diversion from that which is to interest us at this meeting.

"It is a condition that comes many times to the associate members of this Association, and, it may be possible, may not interest the other members as it does the associate members.

"It is the general custom whenever proposals are asked for pumping machinery, and other material that is used in connection with water works, that a certified check is asked for. This check varies in amount from one hundred dollars to five thousand dollars. At the time such a check is certified to by any bank, it is immediately charged against the account of the bidder, and in such action makes whatever the amount of the check may be just so much dormant money. I have personally known of many places where more than twenty-five thousand dollars were so affected for a number of weeks.

"I think that we all know that to make money, money must be kept in

circulation; also there is another condition that is possible to arise, — that after a check has been certified and passed along, a bank may be placed in a position where it cannot honor the check, either for the purchaser or the bidder. If such a condition should arise, then the use for which such certified check was given is voided and its value doubtful and would be an affliction to the one that gave the check.

"To overcome the stopping of circulation of money occasioned by the use of certified checks, and to show a way to accomplish the purpose of the certified check, it is suggested that, in the place of a certified check, a bond issued by any of the responsible bond companies be accepted.

"This is the common custom which the United States Government accepts with proposals made to them, and our thought is, if it be correct for the government proposals, then it should be for your requirements.

"The object in bringing this subject before this meeting is to have it placed on the minutes of this meeting, so that the subject may be given consideration by the Association, and also to try and get an expression of opinions, both from the members of this Association and its associate members, and at such a time as it may be fully discussed, and I trust that the result will be that that which has been suggested may soon become the general custom.

"F. H. Hayes, *Associate Member*."

In addition to that, I have before me a paper that was issued December 10, which came back into my hands February 2. It represented an amount of five thousand dollars divided among five different bidders. This came back to me; I wasn't the successful bidder. I thank you, gentleman.

The Chairman. This matter was considered in the Executive Committee to-day, and it is recommended by the Executive Committee that a committee be appointed to consider this matter and report at some subsequent meeting.

Mr. William S. Johnson. Mr. President, considerable time has been devoted for two recent meetings of this Association to the subject of service pipes, and this is only a continuation of the discussion which has been going on for many years. We have arrived at the same place where we have always arrived. We know that Mr. A uses cement-lined service pipe — he thinks that is the only thing for his conditions and will use nothing else; Mr. B uses lead pipe and thinks it is the only thing for his conditions, and Mr. C. something else; and Mr. D wants tin-lined pipe used.

Now, there are a number of us who do not have a chance to experiment, and we have to recommend what service pipe shall be used in the new systems. I believe there is some reason why

at Brookline they thought cement-lined pipe the only pipe to use, and in another place lead pipe is considered the best. I believe it is perfectly possible to determine what those reasons are, and to give them to the Association.

It seems to me that this is one of the best fields that can be covered by a committee of this Association,— such a committee not only to get statistics; we want something more. We want to know why these things are so different in different places, so that we may be able to determine more nearly in advance what will be the most satisfactory material to use. I would recommend, therefore, that a committee of five be appointed by the chair to consider the whole subject of service pipes and to report at some future meeting. I would make that broad enough, and I think that motion is broad enough, so that it would cover also the question of rigid connections versus goose-necks. [Adopted.]

Discussions on reports of committees were then commenced, the first report being on "Yield of Drainage Areas." The discussion was opened by X. H. Goodnough, chief engineer Massachusetts State Board of Health, who read a paper and replied to a question by Mr. William S. Johnson. Mr. Fuller and Mr. Frederic P. Stearns also spoke on the subject.

The paper on "Meter Rates," which was read by Mr. Allen Hazen, chairman of committee, at the September meeting, was discussed by Mr. Albert E. Lochridge, chief engineer of the Springfield Water Works; Mr. C. W. Sherman, who also read a paper by Mr. Philander Betts, a member of the committee; Mr. D. A. Heffernan; Mr. R. D. Chase, who read figures prepared by Mr. Frank J. Gifford, of Fall River; Mr. W. C. Tannatt, Jr., of Easthampton; Mr. Hugh McLean; Mr. C. N. Taylor; Mr. Henry A. Symonds; Mr. F. L. Clapp; Mr. William F. Sullivan; Mr. Willard Kent; Mr. Walter P. Schwabe; Mr. Francis W. Dean, and Mr. F. N. Connet. Mr. Tighe read a paper by Mr. Morris Knowles, consulting engineer, Pittsburg, Pa. The discussion was closed by Mr. Allen Hazen, chairman of committee.

On motion of Mr. George C. Whipple, it was voted that the discussion of the report of committee on "Filter Statistics" be deferred to the next meeting of the Association.

Adjourned.

EXECUTIVE COMMITTEE.

Meeting of the Executive Committee of the New England Water Works Association at headquarters, Tremont Temple, Boston, Mass., Wednesday, January 13, 1915, at 11 o'clock A.M.

Present: President Frank A. McInnes, and members William F. Sullivan, Samuel E. Killam, Richard K. Hale, Lewis M. Bancroft, and Willard Kent.

Applications for membership were received from Patrick J. Conlon, superintendent water works, North Adams, Mass.; Charles R. Gow, contractor for public works, West Roxbury, Mass.; Dwight L. Agnew, assistant superintendent Scituate Water Company, North Scituate, Mass.; Harvey A. Bancroft, water commissioner, Reading, Mass.; Clarence M. Blair, consulting engineer, New Haven, Conn.; Frank H. Stephenson, civil engineer, Cleveland, Ohio; H. J. Croughwell, clerk, Commission of Public Works, Peabody, Mass.; and they were by unanimous vote recommended therefor.

Adjourned.

WILLARD KENT, *Secretary.*

Meeting of the Executive Committee of the New England Water Works Association at headquarters, Tremont Temple, Boston, Mass., February 10, 1915.

Present: William F. Sullivan, George F. Merrill, Charles W. Sherman, Edwin C. Brooks, Samuel E. Killam, George W. Batchelder, Richard K. Hale, Lewis M. Bancroft, George A. King, and Willard Kent, Vice-President William F. Sullivan presiding.

Five applications for membership were received and recommended therefor, viz.:

Stuart A. Nims, engineer New Hampshire Public Service Commission, Concord, N. H.; John E. Howland, treasurer Tisbury Water Works, Vineyard Haven, Mass.; H. J. Goodale, superintendent public works, Attleboro, Mass.; Edward W. Shedd, consulting engineer, Providence, R. I.; Carl P. Birkinbine, hydraulic engineer, Philadelphia, Pa.

Voted, that Messrs. R. C. P. Coggeshall, Frank E. Hall, Albert S. Glover, and Richard W. Bagnell, charter members of the Association, be recommended to the Association for honorary membership.

Voted, on motion of Mr. Sherman, that the question of place of holding the next annual convention be referred to the next meeting of the Executive Committee and that the Secretary be instructed to notify each member of the Executive Committee of this action and invite Mr. Frank A. McInnes to be present.

On motion of Mr. Sherman, it was voted that initiation fees be remitted to members and associates of the American Water Works Association applying for admission to the New England Water Works Association during the year 1915.

The Secretary presented certificate of renewal of treasurer's bond and it was by unanimous vote approved.

Voted, that the President be and hereby is authorized to appoint a committee on papers and such other committees as he may deem necessary for special investigations.

At the request of President Metcalf, Vice-President Charles W. Sherman was authorized to approve bills and countersign checks in the absence of the President.

Voted, that it is inexpedient to take any action relative to the metric system at the present time.

At the suggestion of President Metcalf, that a committee be appointed to prepare an estimate of the receipts and expenses of the Association for the ensuing year, on motion of Mr. Merrill, the President, Secretary, Treasurer, Editor, and Advertising Agent were constituted that committee and instructed to report at the March meeting of the Executive Committee.

Adjourned.

Attest: WILLARD KENT, *Secretary.*

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New England Water Works Association.

ORGANIZED 1882.

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THE GREENFIELD WATER WORKS.

BY GEORGE F. MERRILL, SUPERINTENDENT OF WATER WORKS.

[*Read December 9, 1914.*]

At Greenfield, Mass., the water works are owned and operated by a fire district, which contains about ninety per cent. of the valuation of the town, and supplies water to the whole town, with the exception of the farming district.

The water supply is taken from the watershed of Glen Brook in the town of Leyden, by gravity, supplemented by an auxiliary pumping station, taking a supply from a well located in the valley of the Green River, near the river.

The original works, built in 1872, are composed of a reservoir on Glen Brook, of about 24 000 000 gal. storage capacity, situated 225 ft. higher than the main street, and located about five miles from the center of the town. At the time of the construction of the system, cast-iron pipe was very high, compared with the present market, and the mistake was made, which was a common one in our New England towns and cities at that time, of putting in mains that were too small.

As the town grew, and its demands for water and fire protection became greater, it became necessary in 1885 to lay an additional 14-in. main to the reservoir, to give better protection in case of fire. This, together with some essential reinforcements of the pipes in the built-up section of the town, was constructed at a cost of about $75 000. The next improvement, other than the regular extension of the mains within the town, was made in

1894. At this time it was found that the 5.5. sq. miles of area which supplies the Glen reservoirs would not in the drought years, with the available storage, yield sufficient water to supply the town. After considerable investigation by committees it was decided to install an auxiliary pumping station on Green River, taking raw water from the stream, and pumping it into the mains through a 10-in. force main half a mile long, where it connected with the existing main pipes from the reservoir to the town. The equipment then installed consisted of a locomotive type boiler, and a 16 by 10 by 10 steam pump, with which it was possible to maintain a supply of water for the town when the gravity supply failed, although at a very excessive cost for pumping. This excessive cost of pumping (about $40 per million gallons) added considerable to the cost of maintenance, but did not amount to a very serious expense until 1909, when an increased amount of pumping became necessary.

About ten years after this original pumping station was installed, the growth of the town made it necessary to obtain a greater supply to carry the town through the dry seasons. The capacity of the pump was insufficient, and the location was such that, in order to get sufficient water, it was necessary to build temporary dams in Green River to raise the water a few feet, so that it would flow into the pump pit. As the river bed at this point was composed of coarse gravel, a large portion of the flow of the stream was lost through seepage; there were also several small water powers located about five miles further up the stream which held back the flow at times, so that there was not enough water flowing to supply the pump.

At this time it was voted to build a storage reservoir above the existing reservoir on Glen Brook, which was expected to store sufficient water to tide over the dry periods. This reservoir was completed in 1906, at a cost of about $85 000. The dam was designed by E. A. Ellsworth, of Holyoke, who worked in connection with Chas. J. Day, a civil engineer, who was at that time chairman of the board of water commissioners. The storage capacity is 44 000 000 gal. This dam raises the water about 45 ft., but, as the reservoir is located in a narrow valley, and the watershed is abrupt, the result is that a comparatively small amount of stor-

age is obtained. A large item of the cost of the reservoir was the construction of the foundation. A pocket was found in the bed of the stream, which had to be excavated to a point 42 ft. below the water level to obtain rock foundation. The whole structure rests on ledge, and is built of 1 : 3 : 5 concrete with large stone imbedded. From the upper reservoir to the lower, and connected below the lower, a 30-in. cast-iron pipe is laid. The gate arrangement is such that supply may be drawn from either reservoir separately, or water discharged from the upper to the lower. The 30-in. pipe is laid along the easterly shore of the lower reservoir, and has been tapped for $2\frac{1}{2}$-in. fire-hose connections at intervals of about 100 ft. along the whole length of the reservoir. During the spring, when the lower reservoir is being cleaned, we use fire hose for flushing out the silt and mud, and find this method very economical and thorough.

The fire department at Greenfield is operated by the fire district, and there are no steam fire engines, all the fire service being obtained from hydrants. The length and size of the main pipes from the reservoir to the town are such that a large volume of water at reasonably good pressure cannot be delivered. About seven years ago, a short time after coming to Greenfield, I became aware of this condition, and hydrant tests showed that, in the center of the town, not over four efficient hydrant streams were available at the same time.

At this time I recommended, as a remedy, the construction of a reservoir on Rocky Mountain, about a mile from the town, to be supplied by the present gravity supply, through a 24-in. pipe.

In May, 1909, there was a very serious fire, which demonstrated clearly the lack of water for fire service. Very shortly afterwards a meeting of the voters was held, at which an appropriation of \$75 000 was made to build a covered concrete reservoir on Rocky Mountain with the necessary pipe connections, and Mr. Wm. S. Johnson of Boston was employed to prepare the plans. The contract for its construction was awarded to Daniel O'Connell's Sons, of Holyoke. The work of installation of pipe valves and laying about 6 000 ft. of 24-in. pipe to the center of the town was done by the water department.

The reservoir is built wholly on ledge, a portion of it being ex-

cavated from the trap rock which occurs on the summit, obtaining in this way sufficient material for the embankment. A concrete floor, 6 in. thick, was laid in alternate sections after the walls were completed. The roof is of groined arch construction, supported by 24 in. square concrete columns, spaced 17 ft. on center. The reservoir has a capacity of 2 000 000 gal. and is supplied through a 24-in. cast-iron main which is laid to the center of the town, and which also protects the main business portion of the town. In operation, this reservoir has a standpipe effect, supplying at all times enough water for fire service. Water flows in during the night to take the place of that which is used during the day. The control of the water level in the reservoir is entirely automatic, and the same 24-in. pipe through which the water supply comes is used for water to return to the town. By the use of two check-valves and a float valve, the water is shut off automatically when the reservoir becomes full, and in case of a slight drop in pressure down-town, a check-valve in the 24-in. outlet pipe opens and water from the reservoir enters the system.

Although the contract to the reservoir was started in 1909, the addition to the system was not completed until the following summer, at which time a hydrant test was made, which illustrates the gain in fire service obtained.

The first part of the test was made with the Rocky Mountain reservoir shut off, and represents the conditions as they were before this addition to the water system. This test was as follows:

With the hydrant pressure at 97 lb. the normal ten fire streams were connected, using 150-ft. lines of $2\frac{1}{2}$-in. hose with $1\frac{1}{8}$-in. nozzles. With these streams, the pressure dropped to 27 lb. With six of the above streams, the pressure was maintained at 39 lb.

The Rocky Mountain reservoir was then turned on, the pressure standing at 87 lb., which is normal from this source. With 16 streams the pressure dropped to $81\frac{1}{2}$ lb. and then four more streams were added, and a wagon-pipe with three-way siamese connection, 50-ft. lines of $2\frac{1}{2}$-in. hose and $1\frac{3}{8}$-in. nozzle. With all the above streams, which were connected with 150-ft. lines of $2\frac{1}{2}$-in. hose and $1\frac{1}{8}$-in. nozzles, excepting the wagon-pipe, which had $1\frac{3}{8}$-in. nozzle, the pressure was maintained at $81\frac{1}{2}$ lb.

The streams with $1\frac{1}{8}$-in. nozzles should discharge, under the

above conditions, about 266 gal. per minute, which indicates that the total discharge with 20 streams and wagon-pipe was about 6 000 gal. of water per minute.

The streams with $1\frac{1}{8}$-in. nozzles, when all were in service at the same time, were sufficient to give effective service at a height of 80 ft.

The wagon-pipe as connected will furnish an effective stream 120 ft. in height.

The upper reservoir on Glen Brook did not accomplish the result for which it was intended, as it lacked sufficient storage. In fact, the first year it was used it was necessary to pump water from Green River at the old pumping station. The question of a further additional water supply was given very careful study before anything was done regarding construction. Investigation of a possible ground-water supply was made over a large area. The first work in this connection was done in the valley of the Barton Brook, lying easterly of the Glen Brook watershed. In this valley we obtained some very encouraging results from flowing wells, and located a good supply of water; but analyses showed it to be unfit for use on account of an excessive amount of iron and chlorine. Further investigation on the same stream up the valley developed a supply of good water, but at such a distance from the town that the cost of development would be quite large; and, as the watershed was a comparatively small one (five or six square miles), it seemed better to depend on the larger Green River watershed, if suitable locations could be found. Therefore test wells were driven, making a very thorough exploration of the river valley from a point about half a mile northerly of Greenfield to the present new pumping station which was built last year. At this point the river valley widens out and, leaving the narrow mountain gorge, enters a more level plain. Test wells driven at this location showed a large bed of gravel containing sharp sand of about the quality of filter sand. The gravel, however, contained many large-sized stones, and some bowlders.

In connection with further investigation of additional water supply, surveys were made up the valley of the Green River to determine the cost of obtaining a gravity supply; also surveys were made above the existing reservoirs on Glen Brook watershed

for a storage reservoir. On the Glen Brook watershed a favorable dam-site was located where storage could be obtained at a cost of about $300 per million gallons. The capacity of a reservoir on this site would be about 400 000 000 gal. with a sufficient watershed to easily fill it in the driest years. When we compare the cost of storage at this proposed site ($300 per million gallons) with the cost of storage at the present upper reservoir (about $2 000 per million gallons) it was evident that proper engineering investigation was not made before the upper reservoir was constructed.

On the Green River watershed, surveys indicated that a gravity supply could be obtained, but it was necessary to construct about 11 miles of pipe line to bring it into town. Green River has a watershed of about 50 sq. miles above our new pumping station. Its source is in the state of Vermont. Our taking would occur at a point so near the Vermont line that a large portion of the watershed would be over the line, where it would be difficult for us to exercise sanitary control. A gravity supply from Green River was not considered the best for our present needs, because of the expense — estimated cost being about half a million dollars, our present needs requiring slightly over 100 000 000 gal. per year to carry us over the dry period, as shown by our pumping records.

The ground water supply which was completed last year was decided upon because of the comparatively small outlay, and the better, cleaner supply of water available. All the work of construction was done by the water department.

Some of the features connected with the new supply were the construction of a large well, and a filter-bed which was built in the gravel about 100 ft. from the well. A low dam was constructed on Green River, about 800 ft. northerly of the well, which raised the water 8 ft., sufficiently to flow on to the filter bed. The pumping station is a brick building with concrete foundations, in which is installed an electric driven pump. There was also laid a 16-in. force main about 2 600 ft. long, which is connected to the existing main from the reservoir to the town.

The construction of the well was done under unusual conditions, and, therefore, may be of interest to water-works men. The wall is built of reinforced concrete, circular in form, and it was sunk

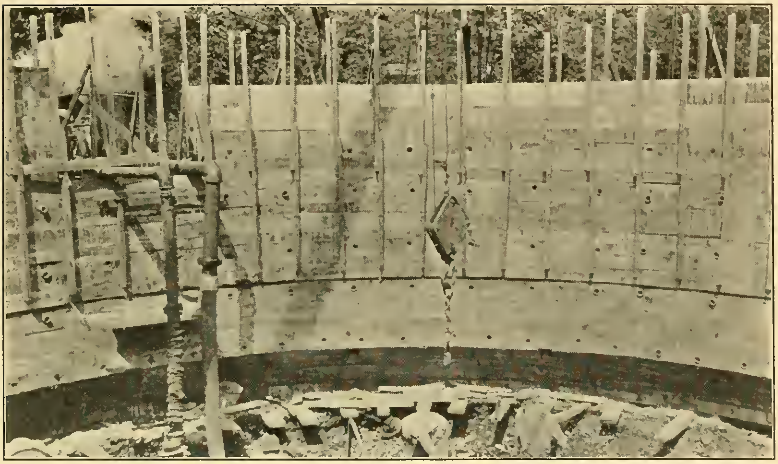


FIG. 1.

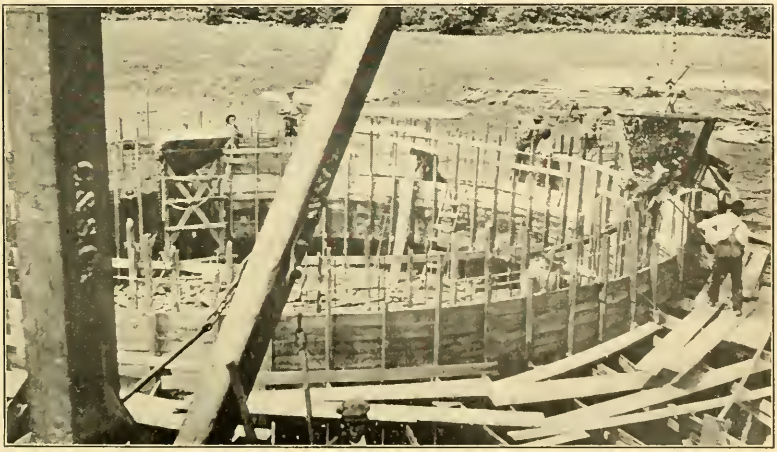


FIG. 2.
CONSTRUCTION OF THE WELL.

into place. The bottom of the wall was designed to act as a cutting edge, and was beveled at the inside lower corner, heavily reinforced. The bevel was made to allow workmen to shovel underneath the edge.

The well is 40 ft. in diameter and 30 ft. deep, twenty-five feet of which is below the ground water level. The first five feet of excavation was made to the water line, and forms were built and the walls of the well constructed about 10 ft. high, projecting out of the ground about 5 ft. Excavation was then carried on inside the well, the water being pumped out; and the wall lowered down by excavation underneath it; also more wall was added to the top until the well was sunk to its depth. It was found necessary to place a pump inside the well, on account of the excessive suction lift, and a centrifugal pump, placed on brackets bolted to the wall, driven by an electric motor and belted connection, was installed. This 6-in. pump worked very nicely under this arrangement, as it was not necessary to lower the suction pipe, the pump following down with the wall of the well as the work progressed. The discharge pipe was constructed in such a way that it would turn on an elbow outside the wall as the well lowered down, without straining the connections. As this pump was about 8 ft. below the ground water level, it was necessary to keep the well pumped out at night.

The well is covered with a reinforced concrete dome, and about 2 ft. of earth, leaving a manhole over the suction pipe. A large number of pieces of 2½-in. pipe were placed in the concrete wall as it was constructed, to allow the water to come through the wall readily.

The pump was built by the Platt Iron Works Company, of Dayton, Ohio, and has a capacity of 3 000 000 gal. per twenty-four hours, against a head of 285 ft. It is a 16 by 18 duplex, horizontal pump, direct connected to a 200 horse-power, slip-ring type, two-speed motor, through a single-reduction or herring-bone gears. After erection, a test was made to determine the mechanical efficiency of the pump, the discharge water being passed through a Venturi meter, and it was found that the plant efficiency was a little better than 75 per cent., which exceeded the guaranty of the manufacturers by 3 per cent.

The cost of electric current, taken on a five-year contract, is $1\frac{1}{4}$c. per kw.-hr. The present cost of pumping is about \$18 per million gallons. The power cost is about \$13.50 per million gallons. During the last season we pumped 2 000 000 gal. of water per day from the well for about two weeks, which filled up the lower reservoir more than was consumed; and for the balance of the pumping season we operated the pump during the night hours (one shift) and obtained in this way sufficient water for our needs, about 1.2 million gallons per day.

The system is about eight per cent. metered. Meters are placed on hotels, railroads, manufactories, and any consumption that comes outside of the ordinary flat rate basis. The average water consumption is about 1 200 000 gal. a day, population supplied being 11 500. Through the summer months, when garden hose is used, this is considerably increased; also during cold weather, when people allow water to run to prevent its freezing, it reaches a million and a half gallons a day.

Total cost of work, about \$450 000. The total bonded debt is \$150 500. Cost of supplying water per million gallons, based on total maintenance plus interest on bonds, \$52.68.

It is interesting to note how the last two extensions — the construction of Rocky Mountain Reservoir and the additional supply — have overcome two serious defects, the lack of fire service and the insufficient supply of water, at a reasonable cost.

In connection with this new work, I have worked under the direction, had the hearty support and aid of our able board of water commissioners, Messrs. C. C. Dyer, Wm. F. Aiken, and Thos. L. Lawler. Wm. S. Johnson, civil engineer, of Boston, was employed as consulting engineer in connection with the Rocky Mountain Reservoir, also on work of additional water supply. George A. Kimball, civil engineer, also of Boston, was consulted regarding details of construction of Rocky Mountain reservoir. Allen Hazen, consulting engineer, of New York, was consulted regarding additional water supply.

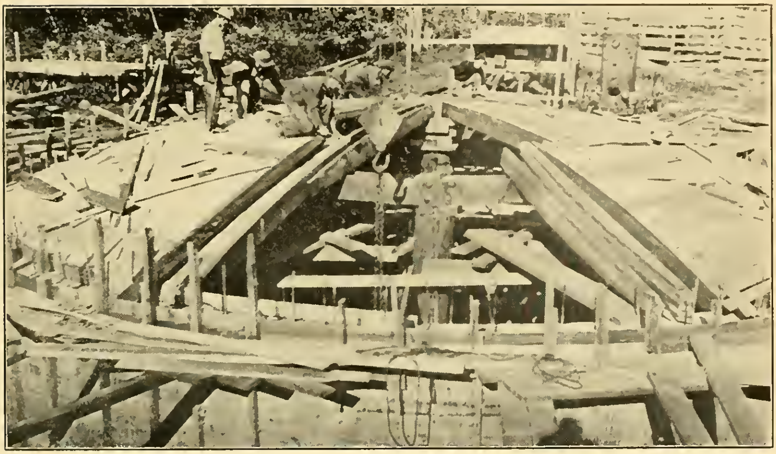


FIG. 1.
FORMS FOR THE DOME OF THE WELL.

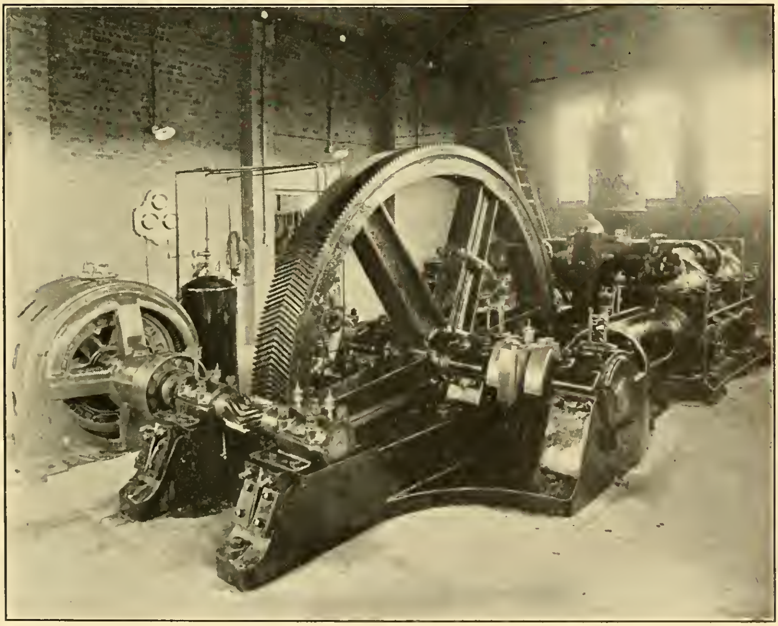


FIG. 2.
VIEW OF THE PUMP.

DISCUSSION.

Mr. G. A. Sampson. I would like to ask if you had any trouble in sinking your well.

Mr. Merrill. We had no difficulty whatever. The well went down readily. I believe in the case of the first section, which was only about ten feet high, one side of the well got uneven bearings on some bowlders and caused a very slight crack in the wall, probably about one sixty-fourth of an inch. But we saw it before the pressure became great enough to do any damage, and we had no further difficulty. As the well went down, the height of the wall and the reinforcement made it much stronger against a breakage of that sort.

Mr. W. S. Johnson. In connection with the construction of the reservoir, we had some experiences which might be of interest which Mr. Merrill did not mention. The bottom of the reservoir was entirely upon trap rock, and there were six inches of very rich concrete, which I certainly expected was going to hold water; but when the reservoir was completed the bottom leaked like a sieve, so much so that we could not fill the reservoir. Mr. Merrill got busy, after the contractors got through, and pumped grout into the bottom and made it practically watertight. But it certainly was something which I had not anticipated, that six inches of concrete on that rock, and a very rich mixture, could not hold water under a 20-ft. head. Mr. Merrill speaks of the filter bed beside the Green River. That is hardly a filter bed. The well is located in a comparatively limited deposit of sand of good filtering quality, and this so-called filter bed is simply an area prepared by scraping off the soil, so that the water discharged on it can enter the sand and find its way at a very slow rate to the well. The idea is simply to keep the sand stratum saturated with water and thus keep up the supply of the well.

Greenfield is one of those towns which was unfortunate enough to build water works before the eighties. They didn't know in those days what our modern water-works system meant. The pipes in such systems are always too small, and every town that built works at that time has suffered ever since from lack of sufficient capacity. Of course some of the large cities have rem-

edied that, but comparatively few of the smaller towns, and it is due solely to Mr. Merrill's activity and his method of presenting things so that the citizens could see them, that this water-works plant has been remodeled and made up-to-date. Of course he would have been a good deal better off if an earthquake had come and destroyed the whole plant, so he could have rebuilt, but considering what was there, and considering the fact that the plant was producing a big revenue, he has certainly accomplished wonders. There is one thing, however, which remains a relic of the past, and that is the system of charging for water. They have, as Mr. Merrill says, but very few meters. The water takers seem to feel that they are paying for all the water they can use, and at times they can use a very large quantity.

Mr. Merrill. Regarding leakage of the Rocky Mountain Reservoir, one might infer from what Mr. Johnson said that it was due to defective concrete. This, however, was not the case, as practically all the leakage that we were able to detect was due to contraction of the floor slabs and wall sections, which were all poured in separate sections. The floor slabs were about seventeen feet square, and the wall sections not over twenty-five feet in length.

The concrete was poured during the hottest summer weather, and the reservoir was filled about the first of November, when the water had a temperature of about 45° or 50° fahr. The work of repairs was done during the coldest winter weather, in order to allow the concrete to contract all that the colder water we have during this season would make it.

The repairs were made by drilling holes in the concrete in the joints and inserting a short pipe nipple which was calked in with jute packing so that it would hold pressure. The discharge hose from a grout pump was then connected to the pipe and grout pumped in. In the walls we used pressure as high as 100 lb. per sq. in. It was necessary, as the grout began to flow out of the joints, to calk them with jute packing in the same manner that the joints of a boat are calked.

In one or two cases, while repairing the floor, the grout appeared in joints about fifty feet distant from the drill hole where it was being pumped in. We did not use as high pressure in repairing

the floor as we did for the walls, as there was danger of lifting the floor slabs.

We used about one carload of cement, reducing the leakage from about 400 000 gal. a day to practically nothing.

In connection with the repair work, we were indebted to Mr. A. E. Lockridge, of Springfield, Mass., for advice, and we used the same method used by him in repairs at Springfield.

A DESCRIPTION OF THE WATER SUPPLY SYSTEM OF COHASSET, MASS.

BY D. N. TOWER, SUPERINTENDENT OF THE WATER COMPANY.

[*Read December 9, 1914.*]

Cohasset is a small town, with a population of about 2 600, situated on the shore of Massachusetts Bay, about twenty miles southeast from Boston.

It is almost entirely a residential community, a considerable number of its citizens going daily to business in Boston. There is some truck and dairy farming carried on, but no manufacturing.

Cohasset is noted for the charm of its rocky shore and wooded drives, which have attracted many to build beautiful homes there. We have a good harbor used principally by yachtsmen, although there is a small fishing industry. I mention this to show that salt water has a value as well as fresh water. The ocean adds very much to the popularity of Cohasset as a summer resort for people who love the open sea and are fond of boating and yachting. Minot's Ledge Light is directly outside of the harbor.

It was in the autumn of 1885 that the scheme of installing water works in Cohasset was first started. Of course the first thing to do was to find a water supply, so we employed Mr. Calvin Horton, of Somerville, to come and drive test wells in some meadow land where the indications seemed promising. He drove nine wells which were connected up and a continuous pumping test was made, and while the test did not come up to our expectations it was decided it would warrant going ahead. That winter plans were prepared, the legislature petitioned, and figures obtained from contractors. The work was not actually decided upon until after our town meeting held in March, 1886, when the town took action in regard to hydrants. At that meeting the town voted to pay a yearly rental of $50 each on thirty-six hydrants. It was proposed to put in about six miles of 4-in., 6-in., 8-in., 10-in., and 12-in. pipe, with a reservoir of one and one-half million gallons

capacity on a hill, favorably located in the center of the town, and 163 ft. above high water, which gives a pressure of from 60 to 65 lb. through the town.

The contract for the pipe laying and building the reservoir was given to Mr. William C. McClellan, the pumps and boilers to the G. F. Blake Pump Company, and the well driving and suction mains to Mr. Calvin Horton. The reservoir was built under the supervision of Mr. Freeman C. Coffin, and the writer looked after the pipe laying, etc. Mr. Horton had difficulty in driving the common 2-in. pipe for the wells. They were driven to a depth of from 25 to 45 ft. through a clay hardpan in which were many small bowlders and through a lower strata of clear clay about 20 ft. thick, down to bed rock. On top of the rock was a stratum of water-bearing gravel about 3 ft. in thickness, so there was very small storage capacity in the ground. The supply system consisted of 62 wells, which with the suction lines to the pumps required the following amount of pipe:

1 860 ft.	of 2-in. driven well pipe.
288 ft.	of 4-in. suction pipe.
530 ft.	of 6-in. suction pipe.
678 ft.	of 8-in. suction pipe.
478 ft.	of 10-in. suction pipe.
3 834 ft.	total.

The work was completed and the pump started in December, 1886. Of course we did not have many services the first year, so very little pumping was necessary to keep the reservoir full.

After two years I began to be bothered with air in the suction mains, which caused the pump to pound. This was very annoying, and after giving some thought to the trouble I conceived the idea of separating the air from the water before it reached the pump. I had a small air pump built and connected with an air chamber of 6-in. pipe about 6 ft. high leading from the top of the 10-in. suction main, which was 478 ft. long, from the sand chamber to the pump. I assumed that the air in flowing through the pipe would rise to the top and flow along in the form of air bubbles. By maintaining an air-pump vacuum slightly greater than the vacuum on the main pump, this air would be drawn

away from the water. I found this plan worked very satisfactorily, and the pump ran as smoothly as though I was drafting from a pond.

Each year the number of services and the demand for water increased, so that I had to draw harder on the wells, and soon found that my air pump was not able to handle all the air, so I put in a second air chamber and pump, which combination answered for about two years. I then had to give up these two small pumps and put in a large 12-in. by 12-in. vacuum pump, which has done the work until the present time. The supply from our original wells was adequate for our needs until 1897, when the question of more water was forced upon us.

Wells were then driven in various places about the town, and every place where there was any indication of water was tested. The soil in Cohasset is very unfavorable for the storage of ground water, it being composed in most cases of clay and sand or ledge; very little gravelly formation is to be found. In a small meadow in the center of the town, we obtained very good results from seven $2\frac{1}{2}$-in. driven wells about 30 ft. deep. A small pumping station of frame construction was built and a $13\frac{1}{2}$ h.p. Hornsby-Akroyd oil engine was installed, with a 7-in. by 8-in. single-acting triplex pump. Here again I was bothered with air, although not from the pounding of the pump as at Station No. 1. In this case, the air being forced into the mains caused the water all through the system to look like milk. An air pump remedied this trouble. Here we obtained 200 000 gal. of water a day, and with this addition to our supply we got along for four years more, but during the latter part of this time we were pretty close to the wind at times, so it was again forced upon us to look for more water.

We have a pond about 57 acres in area and 6 ft. deep, called Lily Pond. It is fed by a brook which has its source in Norwell, and has a considerable drainage area besides. This pond is mostly surrounded by trees, and the bottom is very muddy, so that the water has a color about the same as weak tea. The State Board of Health was consulted in regard to taking water from this pond. They reported that while it was not very satisfactory in color there was nothing harmful about it, and that I might use it as an emergency supply to help me over a time of shortage with

my other supplies. It was then decided to build a third small pumping station here and put in a $13\frac{1}{2}$ h.p. De La Vergne engine, the same make and size as in Station No. 2, and a 7-in. by 8-in. single-acting triplex pump. One year of this was enough, as the water caused great complaint among the takers when we were forced to use it.

Moore & Co. at that time became actively interested in the plant, and they proposed building a gallery at the edge of the pond near the pumping station. Wells were driven along the proposed location first and then a gallery 200 ft. long, 12 ft. deep, and 8 ft. wide was built. It was stoned up about 4 ft. and the balance of the sides and top was of concrete. The material in which this gallery was dug was of clay hardpan, so that the flow of water into it from the pond and the high land adjourning was slow. This supply is limited, so that the pump can be run only about fourteen hours out of the twenty-four. I figure that this supply gives us about 200 000 gal. a day. With these three supplies we continued for three years more, when it was made very evident that we must obtain still more water as our takers were increasing, and many of the summer people were using a great quantity of water on their large lawns.

Mr. W. S. Johnson was then employed to look over the ground and advise us in the matter, and under his direction a number of test wells were driven. Even where water could be found in abundance it was impossible to obtain it from driven wells on account of the sandy formation which prevented a good flow. Mr. Johnson advised digging a test well, which was done. A well 6 ft. by 12 ft. and 15 ft. deep was dug at a point between upland and meadow in a part of the town called Beechwood, where the prospects seemed best for obtaining a supply of water. A steam pump was connected with this well, and after pumping a short time it was found that this water carried a large amount of iron, so this location for a well was given up.

Mr. Johnson then proposed going back into the upland about three hundred feet to try again. A second well was dug about the same size as the first, and here we obtained very satisfactory water. Mr. Johnson did not feel wholly satisfied with this test, however, and had the well put down to a depth of 25 ft. and a

thorough test made by pumping continuously night and day for a month or more. The water continued to prove satisfactory, so it was decided to enlarge the well to 25 ft. in diameter and 25 ft. deep, to build a brick pumping-station and lay about two miles of 10-in. pipe through a street where there was quite an amount of ledge. This work was completed by Moore & Co. in 1909, and the pump was started up just before our annual convention. I started on this excursion feeling quite easy in my mind, thinking that our water question was settled permanently. You can imagine my surprise upon returning home to find the plant shut down for the reason that a large amount of iron had suddenly developed in the water. This was a great disappointment after going to the large expense of putting in this plant. In this station, No. 4, was installed a 25 h.p. Meitz & Weiss oil engine and an 8-in. by $10\frac{1}{2}$-in. triplex pump which would supply 500 000 gal. a day.

Mr. Johnson was soon on the job again, and after looking over the situation he proposed digging a natural filter bed in the ground, on the line of upland and meadow and about two hundred feet from the well, connecting this filter with Bound Brook.

This brook has a history attached to it, as at one time it was a division line between two colonies, Plymouth Colony and Massachusetts Bay Colony; and between two counties, Plymouth County and Norfolk County; and also between two towns, Scituate and Cohasset. The water in this brook has considerable color, as it flows for a long distance through woods and swamps. The bottom of this filter was about 6 in. below the bottom of the brook, a connecting ditch being dug. Mr. Johnson had figured that the brook water percolating through the ground from this filter into the well would act as a blanket, as he expressed it, on the swamp water from which the iron appeared to come, and prevent it from flowing to the well. An improvement appeared at once in the water after the filter was made, showing that it was working out just as Mr. Johnson had expected; but the result was not as satisfactory as he had hoped for, so he advised that we make as many filter beds as we had room for on our land and pump Lily Pond water on to them, as the brook in a dry time would not furnish an adequate supply.

In 1910 three additional filters, each 75 ft. by 100 ft. and about 4 ft. deep, were dug, and a 10-in. spiral riveted pipe was laid through a swamp for a distance of 2 600 ft. to the south side of Lily Pond, where Station No. 5 was erected, in which was placed an electric motor and centrifugal pump.

As only 18 horse-power of the engine in Station No. 4 was used in running the main pump, the other 7 horse-power was utilized to run a generator. This gave us current for operating the motor driving the centrifugal pump at Station No. 5 which supplied the filters with water from Lily Pond. We put in a 7 h.p. generator at Station No. 4 and a 5 h.p. motor at Station No. 5. When this arrangement was put into operation, we found that the amount of iron in the water was very much reduced, but at the same time I had a great deal of complaint from the water takers in regard to the quality. At times the water would be very dark colored and very unpleasant to taste. It caused a brownish deposit in the mains, and when a hydrant was opened the water would come so muddy that I was obliged to flush the mains very often. We got along in this fashion until 1913, when it was decided that something more must be done to improve the water, and advice in this matter was asked of Mr. Robert Spurr Weston.

Mr. Weston used an experimental filter which was set up in the pumping station, and the pump was run continuously about all that winter to supply the filters, the surplus water running to waste. Mr. Weston experimented with and without chemicals, and made a great many tests under different conditions. When the tests were completed he reported that the larger part of the iron could be removed by aëration and sand filtration without the use of chemicals.* It was decided to adopt his recommendations and build a filter plant from his plans. The contract for the whole work was given to the Norwood Engineering Company, of Florence, Mass. They sublet the brick and concrete work to the Briggs Construction Company, of Providence, R. I.

The work was commenced the latter part of March, 1914, and it was finished with the filter plant in operation the last of July. The installation has worked very satisfactorily. The water takers have been pleased with the improvement in the water, and now

* Journal N. E. W. W. A., Vol. 28, p. 31.

I think we have an ample supply of good water which will answer our needs for some time to come.

At the present time I have only 675 services, and to supply them I have five pumping stations. In the first station there is one $8\frac{1}{2}$-in. by 12-in. compound duplex steam pump, a 12-in. by 12-in. air pump, together with feed and vacuum pumps. In Station No. 2, one $13\frac{1}{2}$ h.p. De La Vergne engine, a 7-in. by 8-in. triplex pump, and air pump. At Station No. 3, another $13\frac{1}{2}$ h.p. De La Vergne oil engine, a 15 h.p. electric motor for emergency, and a 7-in. by 8-in. triplex pump. At Station No. 4, a 25 h.p. Meitz & Weiss oil engine, a 20 h.p. electric motor for emergency, one 8-in. by $10\frac{1}{2}$-in. triplex pump, one $7\frac{1}{2}$ h.p. motor and centrifugal pump combined for pumping from the well to the aërator, one 10 h.p. motor and air pump combined to furnish air when washing the filters, and a 3-in. by 3-in. air pump run by water motor from the main pipe which gives from 80 to 100 lb. of air pressure for starting the engine.

It was soon found that pumping water from Lily Pond to the filters in addition to pumping to the reservoir overloaded the 25 h.p. engine, so a change was made by buying electric current and installing a 10 h.p. motor at Station No. 5. I have not used Station No. 5 to pump water from Lily Pond to the old filter beds since the new filter plant has been in operation. I have been using straight ground water from the well, with all the iron that it carries, trusting to the new filter plant to remove it.

If I should be obliged to run night and day, it is more than possible that I should have to pump from Lily Pond on to the filter beds to keep up the supply in the well. Plants Nos. 2 and 4, which have oil engines, are run night and day when necessary without stopping and without attention other than to look them over two or three times a day, fill oil cups, etc. It is unusual to find one stopped, but if I do I am always happily disappointed when it starts up at the first try without requiring the piston to be taken out and a general overhauling in order to locate the trouble, although when found it is usually very easy to remedy. There are now seventeen miles of main pipe and eighty-three hydrants.

If any one here has a larger assortment of machinery for providing so small an amount of water, I should like to hear from him.

DISCUSSION.

Mr. Robert S. Weston. There are some important points in connection with Mr. Tower's paper which might be emphasized. Cohasset is a singular town. Geologically, it consists of a number of rocky pinnacles projecting above the surface of the sea and forming a series of depressions between them. In these depressions nature has dumped more or less material, largely sand and gravel, and the water-bearing strata are contained in these water-tight depressions in the rock. This explains Mr. Tower's statement that he had five pumping stations. The practice has been to tap these little pockets of sand and gravel and extend the works by sinking wells in new pockets.

Many of you know that the water company attempted to take a highly colored water from Lily Pond and purify it by mechanical filtration. This proposition, however, was disapproved by the State Board of Health because they feared the plant was too small to afford adequate supervision.

In the western part of Cohasset the rocky depressions cease, and a region of ponds and dark-colored streams, which latter drain swamps, begins. Naturally, any attempt to win a ground water from the vicinity of these swamps is attended with some danger. This was the case at the Beechwood pumping station. For a while, as Mr. Tower has said, the ground water was practically free from iron, but as the draft increased the water which was beneath the peaty deposits in the swamps reached the wells; iron appeared in the supply, and the measures which Mr. Tower has described became necessary.

The speaker had the good fortune, a couple of months ago, to visit Mr. Tower's works, and observed that the water coming from the filter was perfectly clear and undoubtedly free from iron. Everyone hopes that Mr. Tower has reached the end of his troubles. Having gone from the region of the rocky pockets with their inadequate supply, he has adopted a method which will enable him to use indefinitely the more abundant water from the ponds and their vicinity.

Mr. Hugh McLean. Mr. President, I would like to ask Mr. Tower whether the system is metered.

Mr. Tower. We have fixed rates, except that about twenty meters have been placed on a few of the large summer places. We have many city residents who get there about the first of June and are there perhaps until the middle of October, who have large lawns, with shrubbery and flowers, and are large users of water. I thought I could increase their rates by putting on meters, but in only a few cases was there any increase, as their fixture rates were large, which gives them a large quantity of water during the summer by meter rates. So it is about an even thing. Then there is the cost of setting the meters, which in some cases have to be set in the road on account of having so many outlets between the road and the house. They averaged up about the same as by fixture rate.

Mr. W. S. Johnson. I would like to suggest to Mr. Tower that he might meet the situation with regard to summer residents as one other Massachusetts town has, where they have just put in force a rate of 30 cents per thousand gallons during the winter months and a rate of 50 cents per thousand gallons during the summer months.

In regard to the situation in Cohasset, while the rocks certainly do add to the picturesqueness of the sea coast, they make that town the worst, without exception, which I have ever found in which to get a water supply. It exists, as Mr. Weston has said, only in small pockets, between the rocks, and in the pond described by Mr. Tower, where the water has the color of tea. I believe that Mr. Weston has solved the problem of purifying this water, and I certainly hope, for Mr. Tower's sake, that he won't have to add a sixth pumping plant.

THE STANDPIPE AT WESTERLY, R. I.

BY THOMAS MC KENZIE, SUPERINTENDENT OF WATER WORKS, WESTERLY, R. I.

[*Read March 10, 1915.*]

There probably has been no one thing more radical in its departure from old-established methods of construction in the water-works field than the substitution of concrete for iron or steel for standpipes and water towers. Up to within a comparatively few years the use of concrete for this purpose was practically unknown.

The standpipe at Attleboro, one of the pioneers in this type, was constructed in 1904, and since that time there have been erected in New England quite a number of reinforced concrete standpipes, varying from 32 to 100 ft. in diameter and from 16 to 104 ft. in height, and with capacities of from 108 000 to 2 000 000 gal.

It would seem, therefore, with this wide variation in sizes and capacities, there would now be sufficient practical knowledge on the subject upon which to base our deductions as to their desirability.

The unattractiveness of an iron standpipe cannot be questioned, and it is not to be wondered at that water-works engineers and city and town officials are anxious to find something to replace the iron structures that are so common. The water-works manager, also, I am sure, would gladly welcome a type of construction that would relieve him of the disagreeable work of cleaning and painting his iron standpipe. I say disagreeable, because if he survives the task of satisfying himself, his commissioners, and Citizen Fixit, which one of the fifty-seven varieties of rust-proof paints or compounds is the best for his particular case, he is still up against the problem of determining whether the pitting from corrosion has progressed so far, since the last time he saw it, that the factor of safety now looks to him like minus five.

Quite naturally we are attracted to the picture of a beautiful white standpipe, one that never grows old in the sense of deterioration. The longer it stands there, the more solid and enduring it becomes. It will never require painting, and consequently will not have to be emptied; always full, always ready.

The picture is ideal. Its attainment, I regret to say, is not always accomplished.

The water-works system of the town of Westerly, R. I., was originally built by a water company in 1886 to supply the compact part of the town with water. In 1887 the works were extended to supply the village of Pawcatuck in the town of Stonington, Conn.

The original supply was taken from Shunoc Brook located in the town of North Stonington, Conn. The water flowed by gravity through a 16-in. conduit, 5 260 ft. long, from the brook to the pumping station located near the village of White Rock in Westerly, and was pumped from there through about 13 000 ft. of 12-in. main to a wrought-iron standpipe located on what is locally known as Quarry Hill.

This standpipe, built in 1886 by the Robinson Boiler Works of Boston, Mass., is 30 ft. 6 in. in diameter and 70 ft. high, the water line being 210 ft. above the pumping station, and has a capacity of 380 000 gal.

In 1897 the water-works system was purchased from the original water company by the town of Westerly. Preceding the purchase of the works, investigations were made by the town relative to procuring a new supply, which resulted in adopting the present supply from driven wells, located near the Pawcatuck River. A new pumping station was built, new pumping engines installed, and the old surface brook water supply was abandoned in 1897.

The adoption of the driven well supply necessitated covering the standpipe, and the present roof was constructed on the iron standpipe in 1898.

The consumption of water, at the time of the purchase of the works in 1897, was approximately 400 000 gal. per day, and with two new 1 000 000-gal. pumps, this standpipe provided ample storage.

In 1902 the works were extended to Watch Hill, a shore resort,

or summer colony, located on Little Narragansett Bay, about five miles from Westerly, and by 1910 this, with other local extensions, resulted in an increased consumption of water, during the summer months, to approximately 1 000 000 gal. per day.

The question of additional storage was taken up by the water department, and as the topography of the surrounding country precluded all possibility of a storage reservoir, it was decided to construct another standpipe as near to the present one as possible, the plan being to use both standpipes during the life of the old iron one, and to have the overflows level.

Specifications for a wrought-iron standpipe, and also for a reinforced concrete steel standpipe, were prepared for the water department by Mr. Samuel M. Gray, consulting engineer of Providence, R. I., and proposals were invited for the construction, under these specifications, of a standpipe 40 ft. in diameter and 70 ft. high to the overflow line.

Two proposals were received for the construction of a reinforced concrete standpipe and two proposals for a wrought-iron standpipe.

On the recommendation of the consulting engineer, the contract for a reinforced concrete standpipe was awarded to the Aberthaw Construction Company of Boston, Mass., in accordance with a plan submitted by them, for the sum of $17 760. Subsequent to the signing of the contract, some revisions were made in the plans, enlarging the cornice for architectural effect, which added $962, making the total contract price $18 722.

A water-works standpipe is not generally considered a thing of beauty. On the contrary, they are often spoken of as a blot on the landscape, a necessary evil that, in the case of an iron structure, depending upon the individual tastes of those happening to be in authority, may be a dark red, a dreary black, or a battleship gray.

On the other hand, a leaky concrete standpipe is certainly no improvement, and when in addition to the unsightly appearance is added the feeling of insecurity, which leakage in a structure of this character naturally creates, there is not much that can be said in its favor.

It is, therefore, not the intention of the writer to enter into any

details regarding the relative merits of a reinforced concrete standpipe or an iron one, or to offer any suggestions as to the desirability of either type over the other.

The location in a residential district, the possible architectural features, together with the probable advantage in protection and expense of not having to empty the standpipe for cleaning and painting, and the permanence of the finished structure, were the main factors in determining, in this case, the preference for a reinforced concrete standpipe.

The possibility of having a standpipe with leaky walls seemed to be covered by a clause in the specifications requiring the contractor to "guarantee the safety of the structure and the absence of leakage for the term of one year."

The specifications also stated, "It is not the desire of the water commissioners to build a structure with extremely thin walls, and no bid with walls less than 14 in. thick at the bottom will be accepted, and they may be thicker."

The site selected for the new standpipe was about 500 ft. from the old one, and the work was commenced by the contractors in May, 1910. The excavation for the foundation was carried down about 6 ft. below the surface of the ground, the last 2 ft. being in hard pan. The inside diameter of the standpipe is 40 ft., the height from the floor to the overflow is 70 ft., and from the ground to the top of the ventilator about 88 ft. The walls are 4 ft. thick at the floor line, tapering to 14 in. at a point 5 ft. from the floor, and continue this thickness up to the water line.

An access chamber, 13 ft. long and 4 ft. wide, with a square manhole opening 2 ft. by 4 ft. on the outside and a 30-in. round iron manhole cover on the inside floor, is provided as a means of access to the interior of the standpipe.

The roof is a Guastavino dome of dark red glazed tile and is 41 ft. in diameter and 13-ft. rise. A manhole $2\frac{1}{2}$ ft. by $3\frac{1}{2}$ ft. in the roof also provides a means of access to the interior of the standpipe.

A steel ladder 1 ft. wide runs up the outside of the standpipe. This ladder was erected in 16-ft. sections and is fastened to bronze bolts in cast-iron sockets with 1-in. bronze faces set into the wall at 16-ft. intervals.

The frame tower used by the contractors for conveying the material was large enough for a one-yard Ransome bucket, operated by a hoisting engine. The concrete was mixed in a No. 2 Smith concrete mixer, set in a pit, so that the materials could be dumped into the hopper from the ground. The floor reinforcing consists of $\frac{1}{4}$-in. square rods, 6 in. from center to center both ways. These rods are 1 in. below the floor surface and are bent up 4 ft. into the wall. The main reinforcement is of plain, round, mild steel bars $1\frac{1}{2}$ and $1\frac{1}{8}$ in. in diameter. These bars are 71 and 69 ft. long, so that two form a complete ring, allowing forty diameters for lap, and are held in place by two Crosby clips, such as are commonly used for guy wires. The bars, or hoops, were supported by twelve $1\frac{1}{2}$-in. vertical iron pipes placed 30 degrees apart, and resting on standard 6-in. flanges on the floor. These pipes were coupled in 3-ft. lengths as each successive form was set up. To secure the required spacing of the hoops, $\frac{1}{4}$-in. holes were drilled in the vertical pipes at the proper intervals and hooks placed in these holes, upon which the hoops rested.

Other reinforcing consists of $\frac{5}{8}$-in. round and $1\frac{1}{4}$-in. square rods around the manhole and roof of the access chamber, $\frac{1}{4}$-in. square rods set horizontally, and $\frac{5}{8}$-in. round rods 4 ft. from center to center under the dome seat and bent out into the cornice, and round $\frac{5}{8}$-in. rods, 7 ft. long and 2 ft. from center to center, run vertically up into the parapet wall.

The material used for the concrete was Vulcanite cement, crushed granite, and bank sand. Every precaution and care was used in the selection of materials and in mixing and placing the concrete to secure watertightness. Experiments and tests were made on the ground for proportioning the aggregates composing the concrete to secure the maximum density, dependence being placed on this to make it impervious.

From the results of these experiments, a mixture approximating $1:1\frac{1}{2}:3$ was used for the walls. Tests of the voids in the sands and stone showed that the volume of cement was 10 per cent. in excess of the voids in the sand, and the volume of mortar was more than 10 per cent. in excess of the voids in the stone, as was required by the specifications.

Particular care was given to the bond in the joints. The surface of the concrete was thoroughly cleaned after it had taken its initial set, and a 1-in. layer of 1:3 mortar was carefully spread over the joint before the concrete was poured. Five per cent. of Limoid (hydrated lime) by weight of the cement used was added for waterproofing.

No outside staging was used, the work being all done from a movable platform inside of the standpipe, which was raised by eight differential chain falls as the work proceeded. Wooden forms were used for the base up to the top of the molding, and from this point to the overflow line steel forms were used. These forms were made of $\frac{1}{8}$-in. plate, riveted to $2\frac{1}{2}$ by $2\frac{1}{2}$ in. angle irons, bent to the proper curve. The use of these forms, which was entirely successful, produced a very smooth, uniform finish on the outside of the standpipe.

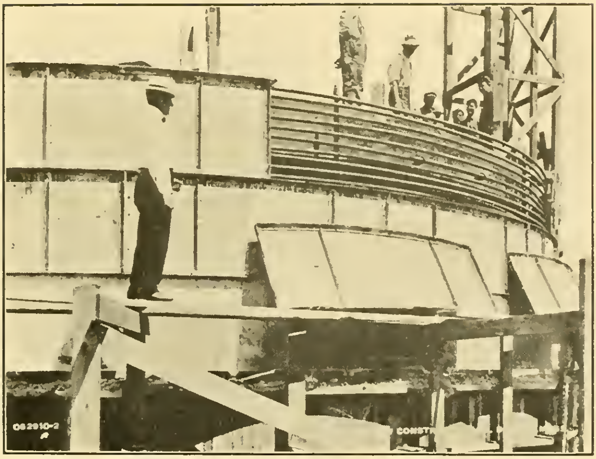
Many interesting problems of construction were successfully worked out by the contractors, and a description of these problems, together with detailed accounts of the materials used, the calculations for stresses in steel reinforcing, the proportioning of the concrete, unit tables of cost, etc., have been described in a paper and discussion by Mr. L. C. Wason, M.Am.Soc.C.E., president of the Aberthaw Company, before the Boston Society of Civil Engineers*; also in a paper† by Mr. W. W. Clifford, Jun.Am. Soc.C.E., of the Aberthaw Company. These papers and discussions so thoroughly cover all of the details of the construction of this standpipe, the writer has simply tried to give in a general way the principal features of the work.

Water was admitted into the standpipe during construction as a means of safety for the workmen, and the only signs of any leakage, while the construction was going on, was a small leak of minor importance near the bottom of the standpipe, very close to the floor. Upon the completion of the work, this water was drawn out of the standpipe to remove the posts and bracing used in supporting the platform and the débris accumulated in the bottom.

The standpipe was then again filled with water on August 25,

* Journal Assoc. Eng. Societies, *46*, 401, 1911.

† Trans. Am. Soc. C. E., *74*, 375, 1911.



SHOWING FORMS AND REINFORCING, WESTERLY STANDPIPE.

1910, and three or four small leaks immediately developed, the principal one being on the joint at the top of the molding. It was at this joint that the steel forms were first set up. The other two leaks were small wet spots, which appeared through the blocks of concrete and were not at joints. These were later plugged up with grout under gas pressure from a carbon dioxide gas tank, and were successfully stopped.

The leak on the joint on top of the molding appeared as a horizontal crack, running nearly one third the distance around the standpipe on the south and east sides, and was apparently caused by a movement of the wall. The leakage was very small, just sufficient to dampen the surface and stain the top of the molding.

The standpipe was put into use until September 20, 1910, when the water was drawn off and an effort was made to waterproof the inside surface with hot paraffine. The process consisted of heating the inside surface of the wall with a hot charcoal fire contained within a wire basket, which was drawn up and down the surface of the wall until it became hot, then hot melted paraffine was applied to the wall with a wide, flat brush, the heat preventing the paraffine from hardening before it penetrated into the surface of the concrete. The wall was then reheated, forcing the paraffine into the pores of the concrete, the process being repeated several times. This process was applied to the floor and 8 ft. up the sides and later carried up 10 ft.

The work was not successful, however, for upon filling the standpipe, the leakage still continued and at this time the crack had increased in length, now being nearly one half the distance around the tank; there was also a trifle more water. More leaks began to develop, all at the joints, and all but one or two on the south and east sides of the tank.

A still further effort was made to prevent the leakage by an application of plastic slate. This method consisted of a belt of plastic slate, 2 ft. 8 in. wide, around the pipe, centering on the crack. It was made up of one ply of plastic slate put directly on to the pipe, then one ply of paper, one more of plastic slate, another of paper, and a finishing ply of plastic slate, the last ply of plastic slate to have enough of the slate dust in it to make it fairly hard and ready for the water.

Unfortunately, this method of treatment was also not a success. While some of the leakage was stopped, it was by no means all stopped, and the preparation made the water taste so bad that we were obliged to discontinue the use of the standpipe and waste the water.

It was now a noticeable fact that each successive time the standpipe was emptied and filled, more leaks developed, all of which were at the joints, that is, at the junction of one day's work with another. These leaks were mostly on the south and east sides of the standpipe.

It was now apparent that nothing short of complete waterproofing of the entire interior would make it watertight. A contract was made by the builders with F. W. Bird & Sons, who guaranteed their material not to make the water taste in any way.

The work was commenced on October 16, 1911, and completed on December 18, 1911. It consisted of the usual method of waterproofing. A specially prepared Neponset compound was applied hot to the wall of the standpipe and then covered with water dyke felt, five successive layers being built up in this way. The work was carried from the bottom of the standpipe to above the overflow line and was accomplished by means of a barrel float, water being let in to raise the float as each successive layer was applied.

The work was entirely successful. The water used in floating the stage was drawn off, the standpipe refilled, and on December 26, 1911, was put into service. No signs of any leakage have developed during the three years of continuous use the standpipe has now had. The area covered was 10 082 sq. ft. The total cost of the waterproofing was \$1 782, or 16½ cents per sq. ft.

There have been some twelve or thirteen reinforced concrete standpipes built in New England, and in nearly every case there has been more or less seepage, amounting in a great many cases to considerable leakage. By leakage I mean water spurting out or running down the sides in streams, a condition that never existed at any time with the standpipe in Westerly.

The intelligent use of the aggregates to determine the voids in the sand and stone, and fixing the proportion in which they were used, produced an impervious concrete, so that no unusual diffi-

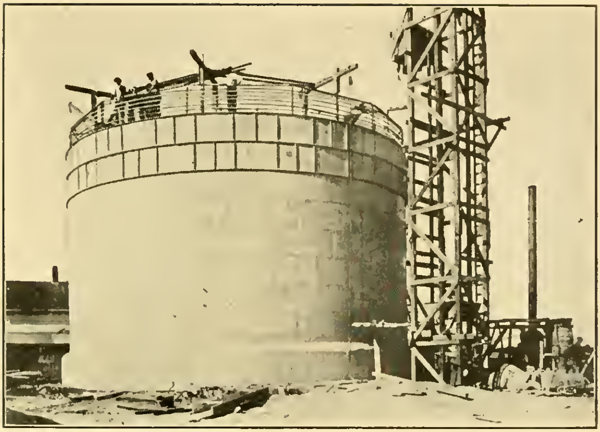


FIG. 1.

FIG. 2.

THE WESTERLY, R. I., STANDPIPE.

culty was experienced from this part of the work. The seepage at the joint, on top of the molding, was undoubtedly caused by the rigid connection of the wall with the floor, which prevented the stretching of the wall under pressure without breaking the bond. It has been suggested that this difficulty can be overcome by disconnecting the bottom of the standpipe and the circular wall, allowing the wall to expand and contract on a slip joint, the joint to be made watertight by the use of elastic asphalt.

In the *Engineering Record* of January 10, 1914, there is a description of a standpipe at Fulton, N. Y., 100 ft. high and 40 ft. in diameter, designed by Mr. William Mueser, M.Am.Soc.C.E., in which this method of construction was adopted. The writer would be glad to know how the theory worked out in practice.

The leakage at the joints, which occurred in increasing numbers each time the standpipe was emptied and filled, was no doubt caused by temperature stresses, because these leaks were always on the sunny side of the standpipe.

The difficulties in securing an absolutely watertight reinforced concrete standpipe would seem to lie in the tendancy to vertical cracks, or breakage of the bond, at the point where compression in the floor changes to tension in the wall, and the unequal tension between the steel and concrete, when subjected to varying temperature stresses.

DISCUSSION.

Mr. H. B. Andrews. Mr. President, I would like to ask Mr. McKenzie if there isn't danger of the rise and fall of ice in the standpipe scraping off the waterproof coating.

Mr. McKenzie. We take our water from driven wells, and the temperature of the water is 54 degrees winter and summer. We have now been through three winters, a year ago this winter being exceptionally severe, and so far as I know at no time has the ice formed in the standpipe. So that in our case I think the danger from that cause is very slight.

Mr. Andrews. If ice should form, as it does in other standpipes, would it not scrape the coating off?

Mr. McKenzie. I should hardly say that, because the last application of asphalt produces a very smooth surface on the inside

of the pipe. The only difference that I could see between the application of asphalt and the application of cement is in the color — one was black while the other would be white. The coating was so smooth that it seems to me if ice should form it would not scrape off the coating.

ATTLEBORO'S REINFORCED CONCRETE STANDPIPE.

BY H. F. CONANT.

[*Read March 10, 1915.*]

One of the first matters called to my attention by the commissioners after my appointment as superintendent of the Attleboro Water Department, in April, 1912, was the condition of the concrete standpipe. Although not serious, it was nearing the time when repairs would be necessary to stop the scaling off of concrete on the outside, and leaks which had been going on ever since the tank was built in 1905, and seemed to be increasing.

I at once began to study the cause of the scaling and leaking and what had been done to prevent it. I learned from the reports of the commissioners that the scaling was in evidence almost as early as the leaking, and that considerable work had been done to prevent it. Referring to the commissioners' report of 1906, I found the following:

"On December 27, 1905, we put the new standpipe into commission, and continued to use it until May 15, 1906. The leaks during that time were very trifling, although during extreme cold weather we noticed a scaling off on the outer surface at certain points, beginning five feet from the bottom of the tank and extending to a point about fifteen feet from the bottom of the tank. This was apparently caused by pockets or cavities that must have existed on the outside of the steel, probably caused by the slight moving of the forms when the concrete was being placed.

"About May 15, 1906, the Aberthaw Construction Company began the plastering on the inside of the standpipe. The first coat had 2 per cent. lime to one part cement and one part sand; the other three coats were composed of one part sand and one part cement. This was floated until a hard, dense surface was produced; then this surface scratched to receive the succeeding coat. This work was done by experts in that line.

"Prior to the plastering the entire inside of the standpipe was thoroughly cleaned and then picked. This was done to insure the bonding of the cement plaster to the surface. There were four coats of plaster put on, and we felt reasonably sure that it would

be perfectly tight, as great care was used in applying the same. But upon filling the standpipe this did not give us the result we expected, as we had felt positive that we should have an absolutely watertight structure.

"At the time the inside work was being done the outside, where the cement had scaled off from the effects of frost, was repaired by digging around the outside row of steel reinforcement, putting on iron clips made of $\frac{3}{4}$-in. by $\frac{1}{8}$-in. iron bolted through, and then cement was forced into the cavities around these clips by throwing it a distance of four or five feet to insure the filling of the voids. This process was continued until the cement covered the entire outer surface, so that further plastering could be perfectly bonded; on this surface was placed expanded metal, forced over the clips that stood out horizontally, and then a coat of plaster was carefully troweled over the surface of this metal, and then a coat of metal placed outside of that plastering, the ends of the clips being turned at right angles to hold the same in place. After this the final outside coat was applied, thus making a very firm and compact surface equal to any part of the structure.

"After noting the result of the interior plastering, we were satisfied that some other method must be used to make the standpipe perfectly tight under one hundred feet head, at the same time realizing that in a warmer climate we should not hesitate to accept it as it was.

"Upon consulting with our engineer and contractor we decided to coat the inside with what is known as the "Sylvester process" wash. We presume many of you are familiar with the same, but for the benefit of those who are not, we will give the formula used on this standpipe.

"Dissolve $\frac{3}{4}$-lb. castile soap in one gallon of water. Dissolve 1 lb. pure alum in eight gallons of water. Both must be thoroughly dissolved. Before applying to the walls the surface must be perfectly clean and dry; temperature must be about 50 degrees Fahrenheit. First, apply soap at boiling temperature with a flat brush, taking care not to form a froth. Wait twenty-four hours so that the solution will become dry and hard upon the walls, then apply the alum in the same way, at a temperature of 60 to 70 degrees Fahrenheit. Wait twenty-four hours, and repeat with alternate coats of soap and alum.

"On the Croton work, four coats of each solution rendered the walls impervious. According to the report made by Mr. Dearborn, a pound of soap will cover about 37 sq. ft., and one pound of alum will cover about 95 sq. ft. Water may be admitted to the tank as soon as the last coat becomes hard and dry.

"This solution has been used with good success on a number of

FIG. 1.

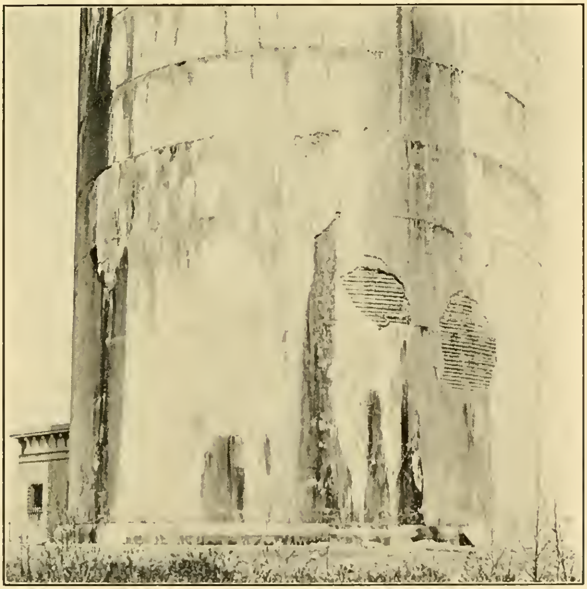


FIG. 2.

THE ATTLEBORO STANDPIPE SPRING OF 1914.

reservoirs, not exceeding a 40-ft. head, making them absolutely tight.

"In order to test this process we decided to try 35 ft. of our standpipe from the bottom up. After applying four coats of the mixture we filled the standpipe full and at 100 ft. head we found there were only four leaks in the 35 ft. coated. On account of this success, we decided to apply four coats more to this same surface, that making eight coats from the bottom up to 35 ft., and above that distance four coats. The result was very satisfactory, but not absolutely tight. As the contract called for a watertight structure, the contractors decided to apply five more coats over the entire surface, thus making thirteen coats for 35 ft. and nine for the rest of the structure. On October 28 the standpipe was filled and found to be practically tight, as the slight wetting on the outside was due to the condensation of the atmosphere. Later a few leaks developed which seemed to come from the inside, but these varied from time to time during the next month. Under certain conditions of the atmosphere the entire surface was absolutely dry; under different conditions it would show a slight leakage. This was so gratifying to the commissioners and engineer that on December 6, 1906, the standpipe was accepted from the contractors under conditions named in contract, viz., to maintain the structure one year from date of acceptance, and if the same continued satisfactory during the winter they were to clean down the outside and wash with neat cement."

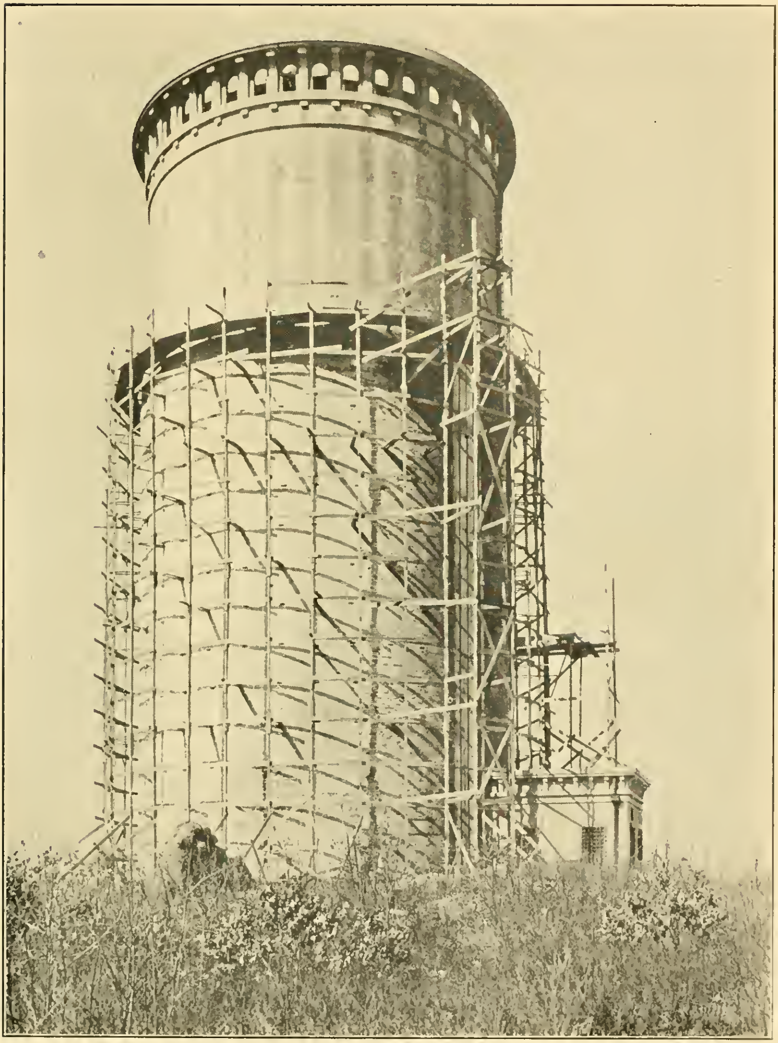
After a careful study, I made up my mind that the main cause of the leaking was due to expansion and contraction, for from observation it had been noted that the leaks varied from time to time, a condition also noticed by the commissioners in 1906, when they were experimenting with plaster and later with "Sylvester process" wash. Another reason for my belief in expansion and contraction was that all reinforced concrete standpipes which I have seen or have data on show more cracks and are in much poorer condition, externally, on the south side than on the north, because of more change in temperature. The hot sun pouring down against the south side of a tank at noonday and the cooling off during the night keeps the concrete in constant motion. Variation in temperature is not the only cause of expansion and contraction. The water in a standpipe seldom remains at the same elevation for any length of time, and as the water rises or falls, so the pressure increases or decreases, and with an increase of pressure, expansion takes place.

The failure of most washes applied to the interior of concrete tanks the size of ours is due, I believe, to the fact that they soon become hard and brittle as the concrete itself, and expansion and contraction soon cracks the wash with the concrete.

From the above data it was apparent to me that the only method to insure any permanency in waterproofing was in an elastic membrane of some description. I next got in touch with the engineers of some of the leading companies building concrete standpipes and it was agreed that elastic membrane was the proper treatment and that such a method had been successfully tried out in the tank at Westerly, R. I., which tank is nearly as large as ours, and built by the same contractors. I learned that Bird & Sons, of Walpole, Mass., did the waterproofing at Westerly, and after going over the matter carefully with them, the commissioners signed the contract to waterproof our tank for $3 000 with a five years' guarantee.

The elastic membrane was composed of felt and cementing compound or hot asphalt, permanently elastic, built up by successive layers, the number varying according to the water pressure, forming a permanent elastic waterproof shield.

The method of applying was simple. After the tank had been emptied and cleaned it was dried out by removing the manhole cover in the bottom and the cover on the roof, creating a strong draft which dried the inside in about three days; after this the bottom of the tank and the walls as high as a man could reach were brushed with wire brushes to remove all sediment, leaving a good clean surface; next a coat of especially prepared paint was put on, leaving the surface ready to receive the first coat of hot asphalt; after the required number of coats of asphalt and felt had been applied to the bottom and for about six feet up on the walls, a raft or floating stage was built inside the tank, the manhole cover put in place and water admitted to a depth of about five feet to float the stage. The melting tanks were placed on top of the standpipe in order that the hot asphalt could be received more quickly on the stage. About five feet per day was completed, and as the water followed the work it was thereby tested for leaks. A band of iron was placed around the inside at the top to prevent the waterproofing from ever tearing away or becoming loose. The



THE ATTLEBORO STANDPIPE, SHOWING THE BRICK COVERING.

Attleboro standpipe received five layers of felt and six of compound. This process is similar to the one used for waterproofing bridges and various other structures with absolute success.

The next problem was to repair the outside of the standpipe. Patching had been tried, as read from the report of the commissioners in 1906. The patches above cited remained for several years, but for the last two winters have gradually scaled off, and as new places had started it was very evident that more patching would make only a temporary job. The question then arose how to make a permanent job.

Several contractors were interviewed and various methods advanced. The casting of more reinforced concrete around the present tank was too expensive and no assurance but what it would scale off as before. Brick seemed the most practical and inexpensive, and after putting the job out for contractors to figure, C. L. Bowen was awarded the contract to build an eight-inch brick wall around the tank, from the original tank foundation to a height of sixty feet. This was determined on for two reasons,— the contractor was afraid that cold weather would prevent going any higher, and above sixty feet the tank was in fairly good condition and would be protected for the winter. By putting on a large force of men and being favored with good weather the sixty-foot mark was reached sooner than anticipated and the second contract to build the remaining thirty-seven feet was signed, but at the seventy-five foot mark cold, windy weather put a stop to the work for the winter, but it probably will be finished in the coming spring.

An air space was left between the concrete and brick to help maintain, as nearly as possible, uniform temperature in the reinforced concrete. Also openings were left in the brickwork, near the bottom, so that the water may run out, in case a leak should ever develop through the waterproofing, thereby saving the brickwork from possible injury and also to give early warning of such leak.

The tank was thoroughly cleaned inside, after the waterproofing job was finished, filled with water, and has been in use since, showing no signs of leakage up to the present time.

CONCRETE STANDPIPES.

TOPICAL DISCUSSION.

[*March 10, 1915.*]

The President. In approaching the subject of reinforced concrete standpipes, it may interest you to have called to your attention in a very general way the progress which has been made in this line.

We find on looking up the literature of the subject that approximately thirty standpipes at least have been built.

It is interesting to note the period of greatest activity. The first standpipe of this sort of which we find mention is one built in Little Falls, N. J., a tank 10 ft. in diameter and 43 ft. in height, built by the East Jersey Company in 1899; in 1903, two more, one at Milford, Ohio, and another at Fort Revere, Hull. In 1904 was built the tank at Attleboro; in 1906, at Waltham; in 1908, two more, one at Bondsville, Mass., and the other in Mexico; in 1909, three; in 1910, four; in 1911, ten; in 1912, four; in 1913, seven; and in 1914, three.

When the subject was first broached, engineers generally had a good deal of anxiety as to what would be the ultimate experience with these tanks, particularly as the heights increased; in other words, as the pressures which they had to meet increased. In the period since 1899 considerable experience has been had with the tanks which have been built; therefore it seems a fitting and live subject for this Association to discuss.

We are fortunate in having with us to-day a number of men who have built the tanks, a number of men who have been responsible for their building, and men who are operating those tanks. So that we should hear the different points of view with regard to them expressed and fully discussed.

Mr. H. B. Andrews.* We have built about seventeen of the thirty or more concrete reservoirs that have been built, all in New

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* Engineer, Simpson Bros. Corporation.

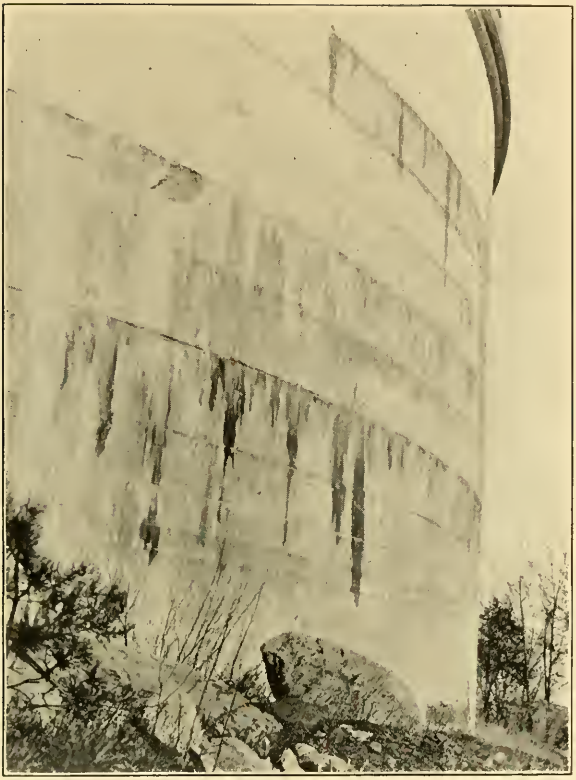


FIG. 1.

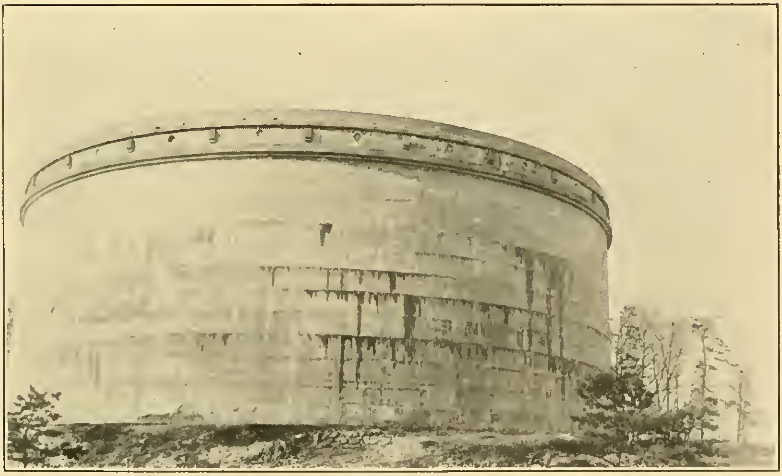
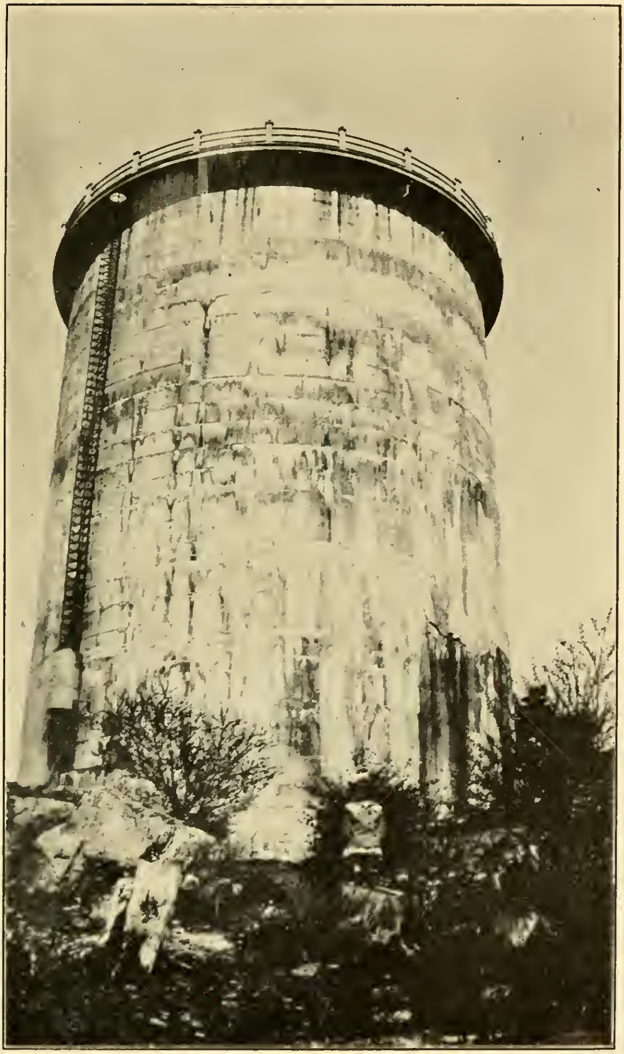


FIG. 2.

THE STANDPIPE AT WALTHAM, MASS.



THE STANDPIPE AT MANCHESTER, MASS.

England. We have had our difficulties in some cases, and in other cases we have not had any difficulty.

We commenced our work by building the Waltham reservoir in 1904. (Plate VIII.) We had nothing to say in regard to the design of this reservoir. It was designed by the city engineer of Waltham, and the plans were gone over by Mr. Worcester, consulting engineer. There was not very much precedent at that time for the design of reinforced concrete standpipes. The proportion of concrete was 1:2:4, and the aggregate was especially selected to make it waterproof. The reservoir was built in successive lifts of about three feet. We anticipated some trouble at the joints if special precautions were not taken to prevent it. The joints were cleaned as we went up, and recesses were made in the preceding day's work by putting in strips of wood entirely round the tank to form a slot to engage the next day's work. The reservoir was plastered on the inside with one-half or three-fourths inch plaster, and in the top half was painted with a neat cement wash. We found after the water was turned into the reservoir that the concrete in itself was not entirely waterproof and that the joints leaked to a certain extent. We decided to make some changes in the next reservoir we built.

The next reservoir we built at Manchester, Mass. (Plate IX). This reservoir was 50 ft. in diameter and 72 ft. in height. We increased the richness of the mix to 1:1.5:3; we also increased the amount of the reinforcement between base and walls. We plastered this reservoir also on the inside, and when it was filled there was but very little leakage. Subsequently two or three cracks developed on the south side of the reservoir, caused by the unequal expansion due to the rigidity of the base and the expansion of its circular shell above, which caused a shear in the concrete and opened up a joint perhaps 30 ft. in length. That was repaired by putting a lead lining over that joint. But the continued change in expansion, due to the filling and the refilling of the tank and the change in the temperature, caused that joint to open again and some water to get in it, so that the leakage reappeared. This reservoir has been repaired by lining it with asphalt and felt over a certain extent of it, so that no leakage appears there now. But it was found necessary to increase the amount and length of

DATA ON REINFORCED

Location.	Inside Diam. in Feet.	Height of Tank in Feet (Shell).	Depth of Water in Feet.	Capacity in Gallons.	Date Constructed.	Total Cost.
Little Falls, N. J.[1]	10	43	43	25 260	1899	
Milford, Ohio	14	81	78	93 000	1903	
Fort Revere, Hull, Mass.[2]	20	50	49 ±	118 000	1903	$4 000[3]
Attleboro, Mass.	50	102	100	1 500 000	1904	35 000
Waltham, Mass.	100	37	35 ±	2 000 000	1906	26 000
Bondsville, Mass.	70	20	20	576 000	1908	
Empalme, Senora, Mex.	30	90	90	475 000	1908	
New Haven, Conn.	50	25		375 000	1908	
Lenoir, N. C.				500 000	1908	
Bridgewater, Mass.	30	78	78	413 000	1909	
Manchester, Mass.	50	72	70	1 060 000	1909	30 291
Lisbon Falls, Me.	50	62	60	910 600	1909	19 288
Westerly, R. I.	40	70	70	650 000	1910	18 722
Rockland, Mass.	46	104	102	1 300 000	1910	36 300
Cherry Valley, Mass.	40	21′ 4″	20′ 9″	195 000	1910	4 976[4]
Rochdale, Mass.	40	21′ 4″	20′ 9″	195 000	1910	4 976[4]
Kensington, Conn.	50	21	20′ 5″ ±	300 000	1910	5 100[5]
Key West, Fla.	78	40		1 500 000	1911	24 950[6]
Laconia, N. H.	28	46′ 1″	43′ 6″	200 000	1911	6 575[7]
Brockton, Mass.	160 each	26′ 6″	25	3 760 000 each	1911	82 200[8]
Western, Mass.[9]	50	38	36	441 000	1911	6 706[4]
Waverley, Ohio	16	82	80	120 000	1911	4 500
Ashland, Mass.	40	32′ 2″	31′ 8″	298 000	1911	5 810[4]
Northbridge, Mass.	25	28	27	90 000	1911	2 899[4]
Suffern, N. Y.	69	20′ 6″[10]	19′ 9″	559 000	1911	6 500
Lexington, Mass.	30	104′ 6″	104	550 000	1912	19 900
Belton, Tex.	24	75	75	254 000	1912	6 000
Winchester, Mass.	29	43′ 6″	40′ 6″	200 000	1912	8 000
Penetanguishene, Ont., Can.	50	21	20′ 5″ ±	300 000	1912	
Austin, Minn.	40	29′ 8″	29	300 000	1912	
Topsham, Me.	97	47′ 9″	46′ 3″	2 500 000	1913	38 000
Fulton, N. Y.	40	100′ 4″	100	940 000	1913	24 335
San Francisco, Cal.	60	35′ 10″	35′ 5″ ±	750 000	1913	
St. Louis, Mo.	153′ 6″[11]	33	31	4 250 000	1913	51 850
Chelmsford, Mass.	40	20	20	188 000	1913	5 180[4]
West Falmouth, Mass.	30	45	45	238 000	1913	9 800[4]
Woonsocket, R. I.	79	45	44	1 600 000	1913	23 514[4]
Sioux City, Ind.	142	33′ 1″	32′ 1″		1913	
Duxbury, Mass.	40	35	35	328 000	1914	7 115[4]
Webster, Mass.[12]	46	20	20	249 000	1914	5 260
Jamestown, R. I.	35	50	49	350 000	1914	10 010[4]
Halifax, N. S.	160	29		3 250 000	1914	56 000

[1] Inside filter house. [2] Inside concrete, brick tower. [3] Excluding tower. [4] Contract price.
[5] Construction only. [6] Including roof, $5 000. [7] Excluding foundation. [8] Two tanks, cost of both.

CONCRETE STANDPIPES.

Engineer.	Built by	References.
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H. B. Andrews	Simpson Bros. Corporation	
H. B. Andrews	Simpson Bros. Corporation	
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F. Fuller		
H. B. Andrews	Simpson Bros. Corporation	
F. W. W. Doane	Standard Const. Co.	Canadian Engr., March 25, 1915, p. 381

[9] Partly below ground surface. [10] Lower half is constructed below ground. Earth backing for retaining wall. [11] At top, 23′; below top diameter=151′ 6″. [12] Protected by earth bank.

vertical reinforcement as cracks appeared at the end of the rod which joined the floor to the wall.

This we did in the succeeding tank which we built at Lisbon Falls. (Plate X.) That tank also was built with 1:1:2 mix, and plastered, and it has not shown any leakage. That was built in 1909. I saw it last summer, and there was no water that leaked out through the tank and reached the ground. There was but one little spot about half an inch in depth and the size of your hand where the frost had scaled off the surface. We found some vertical cracks in the reservoir at Manchester in the plastering and decided that the concrete was not thick enough. That is, there must be thickness enough of concrete to resist the tension in the tank, or else the tank will crack.

In the one we built at Rockland (Plate XI) we built the tank with concrete walls thick enough and strong enough to resist all tension. We did 'not plaster the tank. The forms used consisted of movable wooden sections connected by a bolt extending to 1½ in. from surface fitted with threaded sleeves. Into these threaded sleeves were screwed tap bolts fastening the forms together, and these tap bolts were later removed and the holes plugged for the 1½ in. depth. We found that after the pressure had exceeded some 60 or 70 ft. of water there was enough pressure to force the water through at the plugs that we put in. There was a little channel under the bolts caused by settlement of concrete, and the water filtered through there to the outside plug and caused some trouble through the freezing of water near the surface, causing the scaling off of quite an area. We took out some of those bolts and replugged the holes, and had no further trouble in that respect. We had had some trouble with the joints in the first reservoir built. The Rockland reservoir was 104 ft. in height, and the Lexington reservoir was the same.

The later reservoirs that we have built have not exceeded 50 or 60 ft. in height. In those we used a 1 : 1 : 2 mix of cement, and we find that is impervious to water. We have had no leakage through the concrete whatever, and we have found that that proportion of cement is as good waterproofing material as we can put in concrete. We find that it also increases the strength of the concrete against cracking. The only trouble we have now —

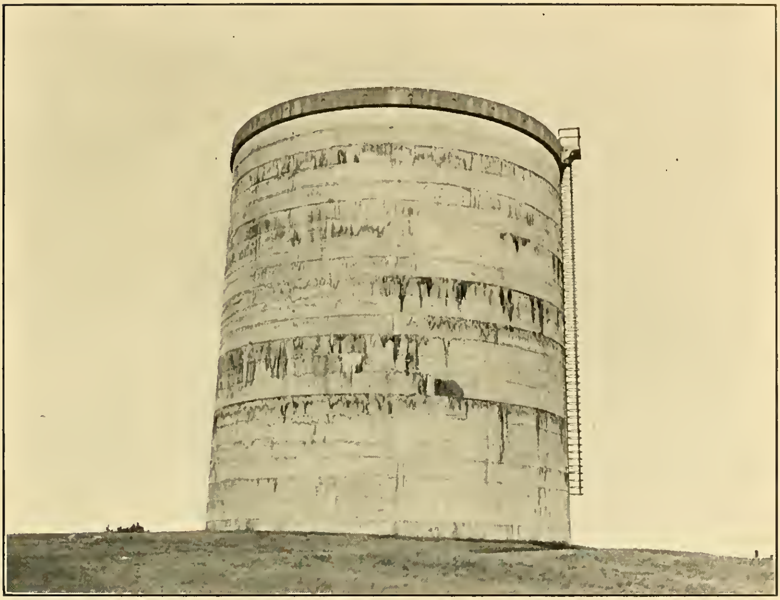

Fig. 1.
The Standpipe at Lisbon Falls, Me.

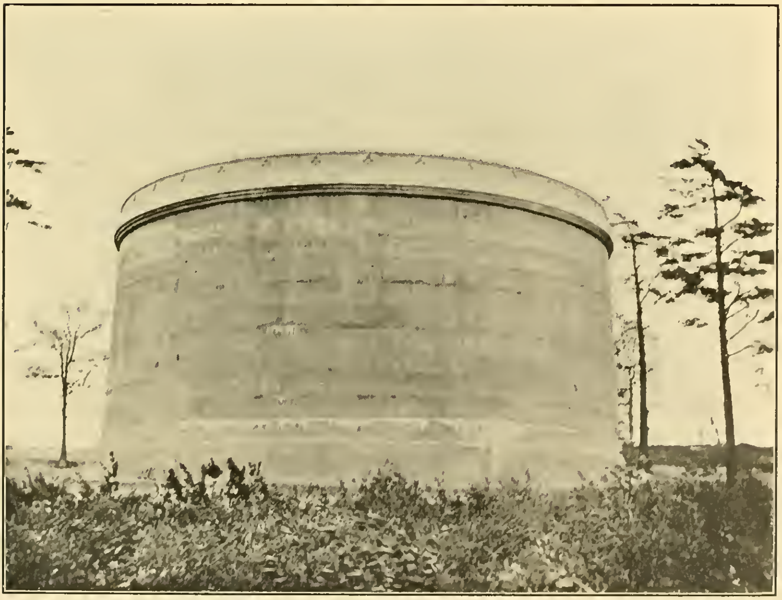

Fig. 2.
The Standpipe at Woonsocket, R. I.

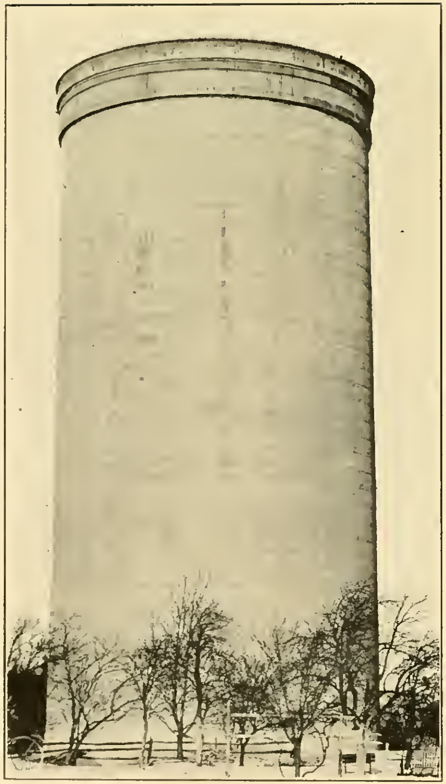

FIG. 1.
THE STANDPIPE AT ROCKLAND, MASS.

FIG. 2.
THE ASHLAND, MASS., STANDPIPE. MARCH, 1915.

and we have had very little of that — is in the joints. Since we built our first reservoirs we have made some experiments on the protection of joints that have worked out very well.

I do not think we have had any leakage whatever in the standpipe at Winchester. (Plates XII, XIII.) On the one at West Falmouth there has been no leakage. On the one at Woonsocket (Plate X), there was a little efflorescence that showed around the joints when the tank was first built; it has now disappeared, and I do not think there is any there now. The one that was built at Jamestown, R. I. (Plate XIV), shows some seepage, according to the picture. There is a peculiar thing about that. I was down there three months after the tank was filled this winter. The superintendent of the water works, Mr. Kent, said there was no leakage of water whatever, and I went over there, and as I approached the tank on the side from which the photograph was taken I could see absolutely no seepage, but there was a little seepage on the other side. Mr. Kent says these spots show more prominently on days when the humidity is high.

In these reservoirs up to 50 or 60 ft. in height we have had no trouble with surface damage by the frost,— only in three reservoirs that I know of. That is the Rockland reservoir, the one that was built in Manchester, and the one that was built at Lexington — for the first 30 or 35 ft. in height, above that no trouble.

Mr. Bertram Brewer.* I have not very much to add to what has already been said. Our standpipe is of considerable interest because it is one of the older ones. This summer it will be nine years old.

I think there is one peculiarity about our attitude regarding the design and construction of the Waltham tank. (Plate VIII.) From the outset we rather anticipated that it would be impossible to get an absolutely watertight tank, and we so told the city government and informed them that it would be well, we thought, to spend the money for the structure, but that they must expect some seepage and possibly some leakage. We did not think, however, that the seepage or leakage would endanger the stability of the structure. Now, with that sort of an article of faith, you can see that the attitude of mind, or rather our attitude of mind,

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* City Engineer, Waltham, Mass.

is somewhat different from that of those gentlemen who thought they were going to get a watertight tank.

The result has been this. The first year or two there was very little seepage; some at the joints, and a good deal of efflorescence and some stalactite formation on the outside of the wall. After being in use for a year or two the seepage began to increase considerably, so that when the tank was full (it is 35 ft. high) a considerable portion of it has been and is quite wet. It never has leaked or seeped sufficiently to cause the water to run down the sides to any extent. It has mostly evaporated before it got to the bottom.

After the first two years this seepage has continued about the same every year. If you went out to Waltham at this time of day, when the tank is full, you would see a large portion of the wall, perhaps a quarter, wet from seepage, mostly from the joints.

The question is vital as to whether this seepage has endangered the tank enough to affect its stability. We do not believe it has. On the lower two feet of the tank, and in one spot higher up, there has been some frost action, so that in places pieces of the concrete have spalled off. In two places around the base of the tank there are small areas where the spalling has reached a depth of three inches. I think that on its ninth birthday it will need a little repairing.

An attempt was made the summer before last to do some repairing on the inside, something along the line of what has been suggested to-day, in the way of applying a waterproof film to the interior. The work was done by a local contractor, and no engineer was consulted in connection with it. As I understand it, it cost something like six or seven hundred dollars. A brush coat of hot tar was painted upon the interior wall. This attempt at waterproofing does not appear to have reduced the seepage at all.

I think I have made it perfectly clear to you, gentlemen, that we do not consider that to-day the stability or soundness of this structure is at all at stake. Up to now the tank has not needed any repairs. At the present time it needs some slight repairs, as has been indicated.

Mr. Raymond C. Allen.* My experience, like that of Mr.

* Civil Engineer, Manchester, Mass.

FIG. 1.

THE STANDPIPE AT WINCHESTER, MASS.

FIG. 2.

THE STANDPIPE FOR THE SUMMER CAMP OF THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY, AT GARDNER LAKE, ME.

Plate XIII.
N. E. W. W. Association.
Vol. XXIX.
Topical Discussion.
Standpipes.

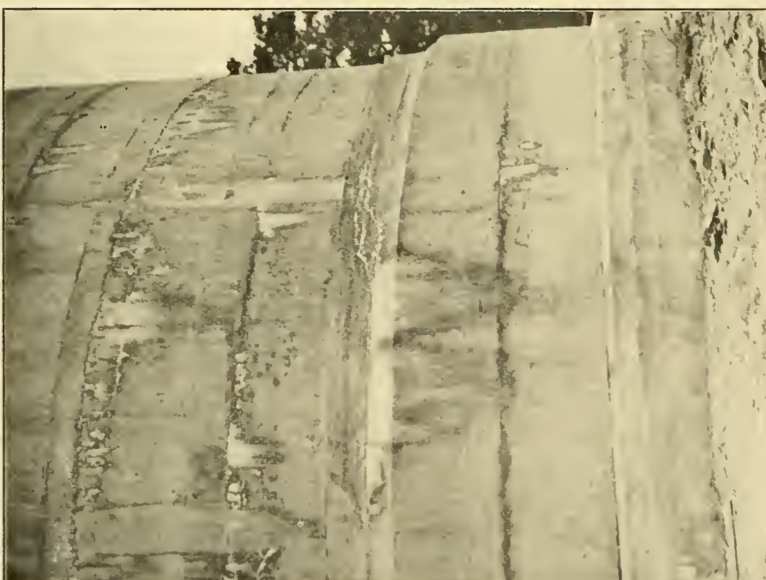


Fig. 1.

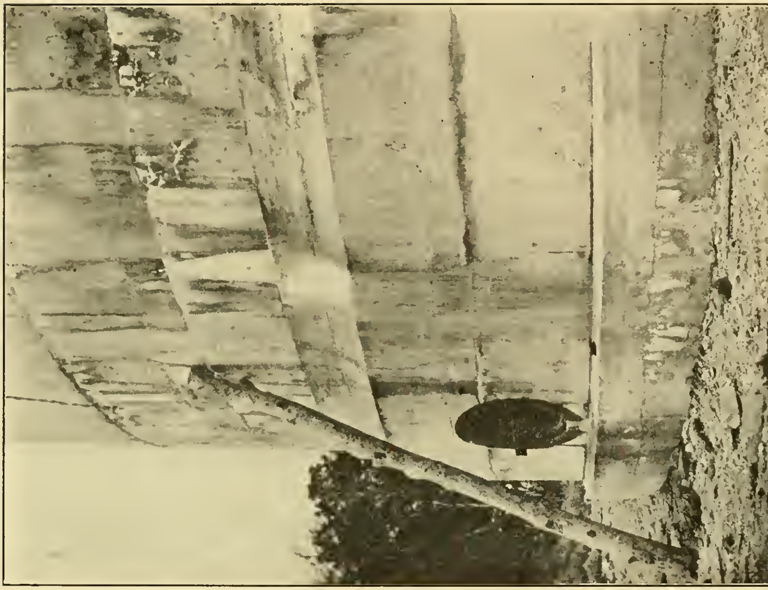


Fig. 2.

The Winchester, Mass., Standpipe. March, 1915.

Brewer, has been limited entirely to the standpipe with which I have been connected, although, like every one who has had any part in the responsibility for a concrete standpipe, I have made considerable study and observation of others.

The standpipe at Manchester (Plate IX) was built very carefully, and of the best materials. Shortly after it was filled a fracture appeared at the first joint at the base, which in a short time extended a length of about 30 ft. Through this fracture the water in a short time came in a sheet, over a length of from 10 to 12 ft., and trickled through at other points. One other leak of quite considerable proportions appeared about 15 or 16 ft. up. This was not as wide as the other, but similar. There was no other leak, but there was a seepage at many of the joints.

We tried first a cement coating. We found it unsuccessful. Then the two joints which were in the worst condition were repaired by putting a layer of lead with tar over them, as Mr. Andrews has described. This sealed these joints until a year or two ago, when the pressure forced the water into that crack to the extent of fracture, and the leaks again appeared.

Those two leaks have been repaired about a year ago by a similar waterproofing process to that, a description of which you have heard to-day, and the standpipe has been protected within by some further construction against ice and other damage.

I think there are one or two points that have been brought out by Mr. McKenzie with which my experience and observation on the standpipe at Manchester coincide. I have noticed, first, that the greatest amount of seepage and of leaks has occurred on the south and west sides, where the expansion seems to be most unequal. I have also noticed that as from time to time the standpipe is lowered entirely and filled again, the successive fillings have produced new points of seepage. At all events they act a little differently, and are cumulative in their effect. Thus each time a standpipe is emptied and filled, I believe that a slight increase in seepage for a time at least takes place.

We at first feared the action of frost, — although our fears were somewhat allayed at the time by others who had built concrete standpipes. Last year we had a piece about eight feet square thrown off at about the location of the upper leak to which I have

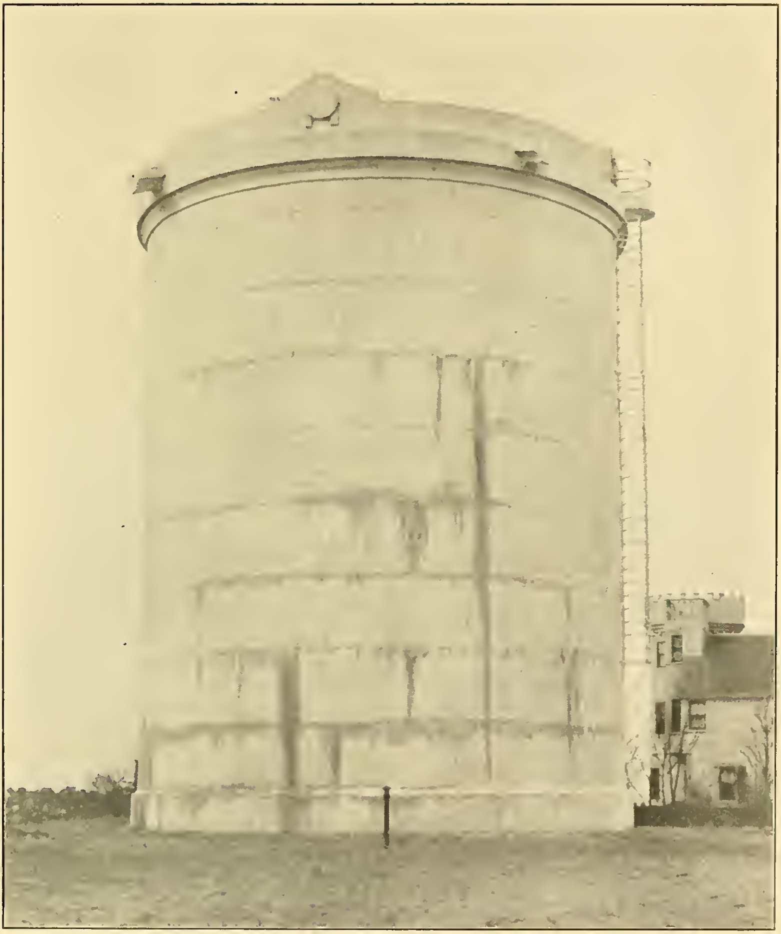
before referred. This was clearly the action of frost, and the action of it upon the concrete was to completely disintegrate it. It was just so much sand. That was true upon some portions of the base upon which the water had been constantly running and freezing, but behind the reinforcement, where no movement of concrete had taken place, there was no disintegration. It was only in the outer shell where disintegration took place or any damage appeared in the concrete. I think Mr. Andrews' observation will bear me out in that.

I have come to the conclusion, myself, that such standpipes as are over about 50 ft. in height should be entirely waterproofed on the inside by some preparation similar to those described here. I will go a little further and say that I feel that the outside of the tank itself should be protected from the elements. For while the greatest danger from frost comes from the freezing of seepage through the structure, I believe that in time at least the action of snow and rain and the water coming down from the roof will have the same effect as it will when a larger amount of water comes through from the inside in the form of seepage.

The appearance of the outside of the standpipe is due to efflorescence and not to leakage. On the right of the picture and about one third up from the the bottom of the standpipe may be seen the outline of a patch put on to the standpipe about a year and a half ago to replace the portion thrown off by the frost and referred to in my discussion. The only leakage in the pipe at the present time is at or near this patch, and this leakage is a drop at a time at two points, somewhat similar to the drip from a faucet which is not quite tight.

Mr. Francis W. Dean.* I was probably more responsible than anybody else for having a reinforced concrete standpipe built at Lexington. (Plates XV and XVI.) I was on the Board of Water and Sewer Commissioners at that time, and it became necessary to build a standpipe. I felt quite strongly that it ought to be of concrete rather than of steel, and I succeeded in influencing my fellow members to that belief. My idea was to have something permanent and something that was more attractive-looking on the landscape than steel.

* Mechanical Engineer, Boston, Mass.



THE STANDPIPE AT JAMESTOWN, R. I. MARCH, 1915.

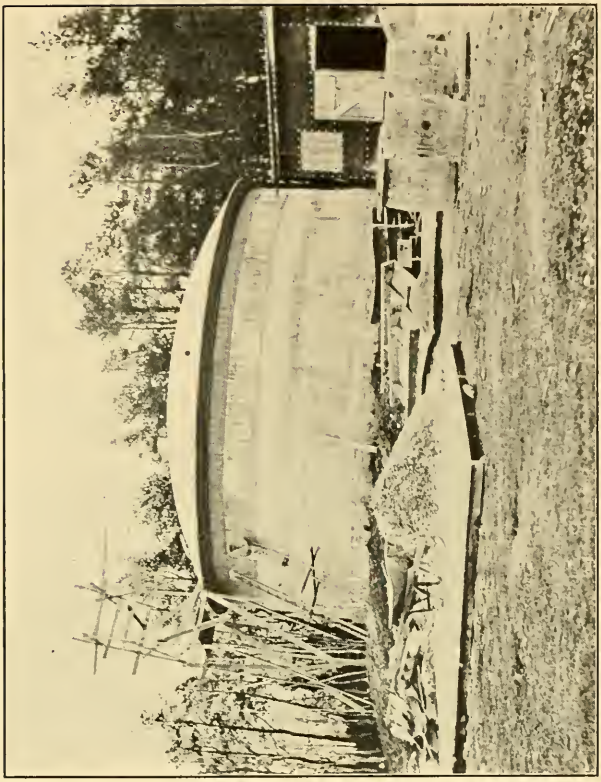


FIG. 2.
THE STANDPIPE AT CHELMSFORD.

FIG. 1.
THE STANDPIPE AT LEXINGTON, MASS.

I think as far as the latter feature is concerned it was successful, and in general the standpipe has been satisfactory. I should judge that it has been fully as satisfactory as any standpipe of that kind.

If I remember rightly, an effort was made to prevent leakage in the first place by pasting canvas on the inside, using marine glue. It was supposed not to dissolve, but some mouths later it was found that most of the canvas was at the bottom of the standpipe.

Furthermore, the leakage was confined to quite a small area, and chiefly on one side, about 25 ft. from the bottom, as I remember it. Afterwards, when cold weather came, a small part of it spalled off, and that has been repaired. I believe the leakage now is almost nothing.

In advising this to the members of the Board I of course looked up the matter of reinforced concrete standpipes, and had a talk with Mr. Brewer, who I knew had been through a good deal of the trouble. He strongly advised it, I felt perfectly safe in advocating it, and I do not think that so far any mistake of importance has been manifest.

Mr. William S. Johnson.* My experience has been limited to rather low tanks, and unless I change my opinion very materially, my future experience will have the same limitations. None of the tanks which I have built is over 40 ft. in height, but they all leak more or less. There has been no spalling off of the outside surface, and the actual quantity of water passing through the concrete is very small, but it is enough to make the tanks unsightly, and, of course, arouses a certain suspicion as to the safety of the structure in the minds of those who know little about these matters.

I am convinced that high standpipes are much better built of steel than of concrete. To be sure, the steel tanks are unsightly, but so are concrete structures, discolored by leakage. The repairs on a steel tank are expensive and annoying, but they cannot be more so than the repairs to concrete tanks which have been described in such detail here to-day. As to the durability, the evidence indicates that concrete tanks are far from indestructible,

* Civil Engineer, Boston, Mass.

and there is much uncertainty as to how long they will really last.

Until some better method of designing and constructing concrete tanks is found, it seems to me very unwise to install them to hold more than 50 ft. of water.

Mr. Simpson.* As Mr. Dean said, there are three joints that scaled off of the Lexington standpipe which were fixed with canvas. We are absolutely ready to build tanks up to 110 or 115 ft. high, and we can build them perfectly, but not without an interior lining.

I want to ask Mr. Allen if I am correct in stating that they have an exceptional condition down there, in which they fill their standpipes at four o'clock in the summer months, and fill up to something like 60 ft. of water, and then stop pumping, and it goes down to 30 or 45 ft. before the end of the afternoon, thus getting every day in the summer a height of 25 ft. in the afternoon and 70 or thereabouts the next morning. This was one of the things that led us to say that the walls of a concrete standpipe must be heavy enough to have no movement whatever.

Mr. Charles W. Sherman † (*by letter*). I have recently had opportunity to make a personal examination of the present condition of the Lexington and Winchester standpipes and have taken some photographs illustrating this condition, which are shown in Plates XVI and XIII.

The Lexington standpipe, as might be expected from its great height, has been more affected by leakage than the one at Winchester. It is particularly to be noted that the real damage to the structure appears to have occurred mainly between 10 and 20 ft. above the bottom, rather than at the joint between the bottom and sides of the structure, and that the damage is not confined to the south side, but appears also on the north side as well as on the east and west. There are four particularly noticeable spots of damage, corresponding roughly to the four cardinal points of the compass, and all of the same general character, as shown by the accompanying photographs. In these spots the concrete outside of the reinforcement appears to have been bulged out by frost a maximum distance of perhaps six or eight inches and has the appearance of being nearly ready to spall off. The photographs

* Of Simpson Bros. Corporation.

† Of Metcalf & Eddy, Engineers, Boston, Mass.

South Side. North Side. West Side.

VIEWS OF LEXINGTON, MASS., STANDPIPE, TAKEN IN MARCH, 1915.

were taken on March 20, 1915, and even on that comparatively warm day icicles extended from the cracks to the base of the standpipe. In addition to these larger damage spots, there were a considerable number of comparatively insignificant evidences of seepage, some of them as high as 40 ft. above the ground.

At Winchester, there was, at the time of my visit, no evidence of real leakage, although there were two or three damp spots. There was, however, very noticeable efflorescence at the joints between day's work, and particularly in the lower 10 ft. or so. There was some efflorescence almost to the top of the tank.

Mr. Stephen Litchfield * (*by letter*). The standpipe for the town of Lisbon, Me. (Plate X), was completed in October, 1909, and put into commission in January, 1910. The diameter is 50 ft.; the height, 62 ft. (internal dimensions); capacity, 190 600 gal.; thickness of shell at base, 20 in.; at top, 12 in.

The structure is designed on the basis of the steel reinforcement, taking all tensile stresses at a working unit stress of 12 000 lbs. per sq. in. in the steel with the standpipe full.

The structure rests on a hard-pan bottom. Floor slab is 20 in. in thickness, of 1:2:4 concrete reinforced with 3-in. No. 10 standard expanded metal. Over the concrete base or floor is a 1-in. granolithic surface 1 : 1 mortar with 2 per cent. of Medusa Compound added to the mix.

The walls are composed of 2:1.5:3 concrete. Bank gravel, screened and washed, was used in the mixture. In the top of the floor and in walls 5 per cent. of hydrated lime added to the weight of the cement was used. The entire inside perimeter of the standpipe is plastered with $\frac{1}{2}$ in. of cement mortar mixed 1:1, with 2 per cent. of Medusa Compound added to the weight of cement. The plaster to a height of 30 ft. is painted with waterproofing compound.

Forms were constructed in three sections, the lower section being transferred to the top each day, one day's work consisting of one lift or section of 30 in.; in one instance, however, two lifts were placed in one day.

Horizontal steel bars or hoops varying in size from $1\frac{3}{4}$ in. to $\frac{3}{4}$ in. were held in place by fourteen latticed steel columns.

* City Engineer, Bath, Me.

The tank is roofed with a Gustavino dome, outer covering of which is plastic slate. Dome has a rise of 8 ft.

The standpipe was designed and built by Simpson Bros. Corporation, Boston, Mass.; contract price, $19 288.

There have been no items of repair or maintenance since the work was completed.

There is more or less seepage apparent at times, which shows at joints or where one day's work ends and another begins. Many places where seepage has occurred in the past are now entirely free from it, which leads us to believe that the structure is improving with age.

We are well pleased with the standpipe and consider it as near an approach to a permanent structure as it is possible to obtain. We feel, however, that if we had made the placing of concrete continuous, or nearly so, we would have eliminated the cause of seepage. Instead of depreciation, as is the case when other materials are used in similar structures, we consider that this one is improving. As stated above, there has been no item of maintenance to date, and there is every reason to indicate that this item is practically eliminated.

Mr. Charles L. Bowker (*by letter*). The Topsham standpipe of the Brunswick and Topsham Water District (Plate XVII) is 97 ft. inside diameter, with a conical bottom, the incline from the bottom to the beginning of the wall being 3.25 ft. rise in 10 ft. The foundation rests on solid ledge and was filled with rubble masonry laid in Portland cement mortar. The wall at the base is 3 ft. thick, and at the top 16 in. The water line is 46.25 ft. from the floor; 18 in. more to the roof. The roof is a concrete slab 7 in. thick, sloping $\frac{1}{2}$ in. to the foot, supported by nine concrete piers, eight of which are 18 in. in diameter, and the ninth, having an 8-in. overflow pipe imbedded in the concrete, is 24 in. in diameter. The top of each pier is cone shaped, the top being $5\frac{1}{2}$ ft. in diameter and having a rise of 24 in. An iron ladder is fastened to the outside of the wall. There is no ladder inside, neither is there a manhole in the wall. The 16-in. intake pipe is imbedded in concrete and is elevated 12 in. above the floor. There is an 8-in. flush pipe connected in the gatehouse with the 8-in. overflow, operated by opening an 8-in. gate, and the opening of this pipe is about an

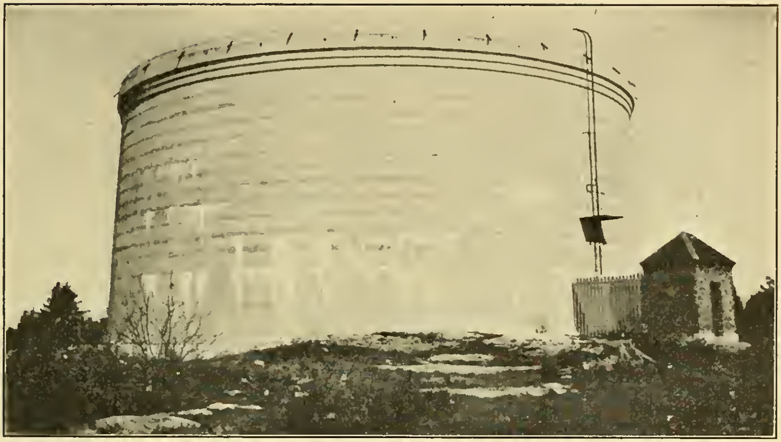


FIG. 1.

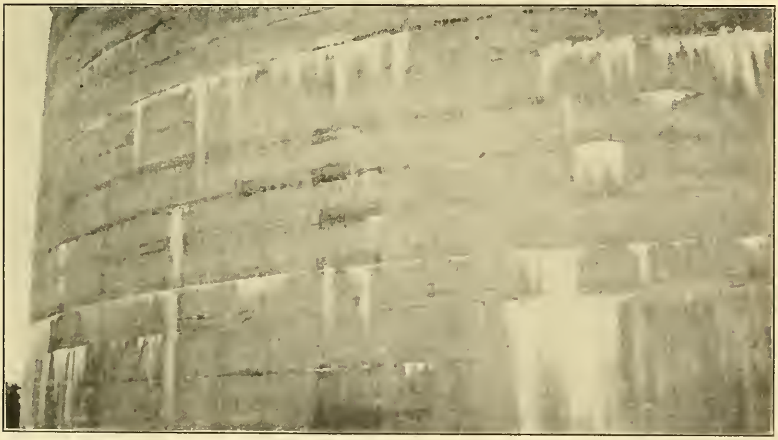


FIG. 2.

THE STANDPIPE AT TOPSHAM.

inch below the floor of the standpipe. There is a ventilator at the peak of the roof, with four ports, and numerous four-inch holes for ventilation in the wall, close to the roof. All openings are screened.

In the construction of the standpipe particular care was taken to remove all loose rock under the foundation. In the center, considerable blasting was done. The bottom of the standpipe was built in two layers, each 6 in. in thickness, after first leveling to the proper grade, the second layer being reinforced with $\frac{1}{2}$-in. round iron. The floor was troweled to a smooth surface, the finishing coat being cement mortar, 1:2 mixture, with the addition of 5 per cent. of hydrated lime, the same amount of lime also being added in the second layer of concrete.

The wall was reinforced horizontally with iron rods of various diameters, from $1\frac{1}{4}$ in. at the base to $\frac{3}{4}$ in. near the top, supported on lattice work which was built into the wall. The proportion of the concrete mixture for the wall was 1:2:3.5, with 5 per cent. of hydrated lime. A "T" iron, 6 in. by 12 in., was built in the foot of the wall, circling the standpipe, reinforcing rods anchoring this to the floor of the standpipe.

The method of building the wall was by placing the concrete in movable forms, the forms being held in place by bolting one section to the next, depending on the bolts entirely to hold the outside forms in place. An elevator was used to hoist the concrete to a runway around the wall, and the concrete was placed with wheelbarrows.

The roof was built during cold weather, and on the night it was finished it collapsed. There were various opinions as to the cause of this. During the time the concrete was being placed live steam was discharged into the standpipe to keep it warm underneath the roof. The supports for the forms were built and used as staging for the wall, and it is possible that the carpenters might have been careless in their work, perhaps weakening some place where strength was needed. Only one pier fell, the others being in use to-day. The roof was rebuilt in the spring of 1913 on exactly the same lines as before, even the reinforcing rods being straightened and used again. The roof appears perfect at this date.

All material used was subjected to the usual tests, being specified in detail in the contract.

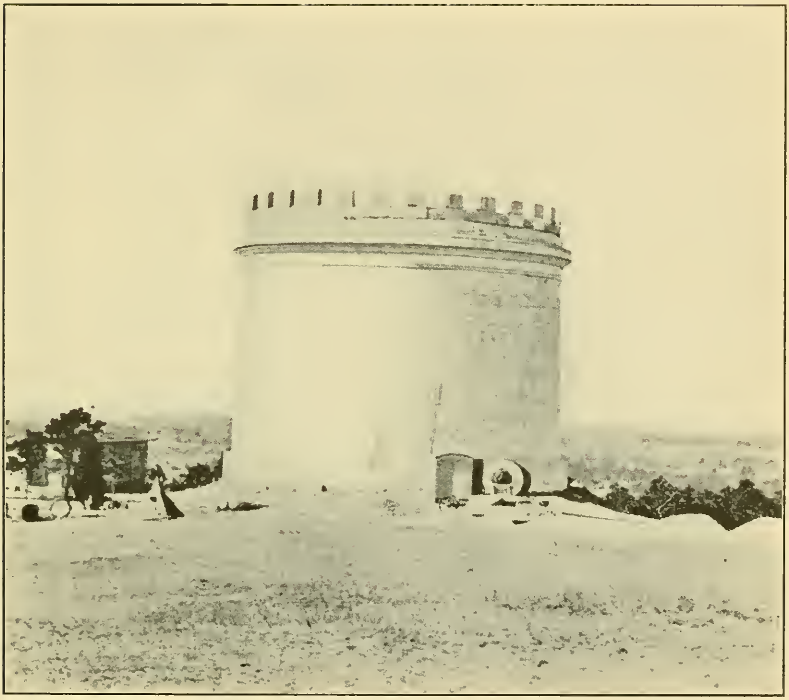
When the standpipe was first filled, various small leaks developed, on one horizontal ring in particular. To remedy this the contractors cut a recess into this joint with sharp chisels and calked it with lead wool. At this date the condition of the standpipe is very good and it is practically tight. A few damp spots appear at times, depending on the weather, but they could not be called leaks. Thus far there does not appear to be any damage to the wall from frost, and the concrete is apparently as good as when first completed.

It might be possible to construct a standpipe by building an outside wall of cement blocks, built on a batter, using them in place of a form of wood. The inside forms, being vertical, could be made of wood and their position easily and quickly changed, filling in the concrete from a spout fed by an elevator, pouring it continuously, and by this means having no dry joints to bond together. In Brunswick and Topsham there are four concrete watering troughs, each of which was built in one pouring, and there is yet one to be found that is damp on the under side. If the same principle could

Detailed Cost of Concrete Standpipe and Force Main to March 9, 1915.

Land	$750.00
Surveying same and looking up title	22.90
Advertising bids	2.00
Special castings, etc	262.81
Freight	34.88
Copper conductors	68.00
Platform, total cost labor and material	41.00
Pay-rolls, work done by District	46.25
Miscellaneous expense, telephones, teams, etc	27.56
Total amount paid contractors	*37 932.02
Engineering and inspection	1 900.00
Total, account standpipe	$41 087.42
14-inch force main, cost to date	4 387.07
Total	$45 474.49

* $38 000 less amount charged to contractors for labor and material furnished by District.



The Standpipe for the Duxbury Fire and Water District.
Leaks showing are the only ones that appeared. March, 1915.

be carried out in building a concrete standpipe there would be no leaks. The water in the standpipe would keep the wall at an even temperature, and if the wall was built strong enough there would be little danger from expansion and contraction.

Diameter, 97 ft.; depth of water, 46 ft. 3 in.; height of wall, 47 ft. 9 in.; year built, 1912–1913; cost, $38 000.00; capacity of standpipe, 2½ million gal.; engineer for District, L. D. Thorpe, Boston, Mass.; engineer in charge of work, J. H. Caton, 3d, Manila, P. I.; contractors, Simpson Brothers Corporation, Boston, Mass.

Mr. S. S. Gatch * (*by letter*). The concrete standpipe at Milford, Ohio, was erected in 1903 and is apparently in better condition to-day than when finished. After using it about two years some seepage was noticed. The water was drained out and the inside dried and coated with a cement wash. Since then there has been no seepage. The seepage was evidently caused by joints in the construction because of delaying the work at night and over Sundays.

We believe the water is kept in better condition in a concrete standpipe of small diameter than in one of any other material, but think for best results the work of construction should not be delayed from start to completion.

Basing our opinion on an experience of about twelve years, we recommend the concrete standpipe properly built on a firm foundation as better and cheaper than any other.

Mr. D. C. Webb.† My experience with concrete standpipes is confined to the design of one at Key West, Fla., in 1909. This standpipe, or cistern as it was called, is 80 ft. in diameter, 40 ft. high, and has a capacity of 1 520 000 gal.

I was detached from duty at Key West before the construction of this standpipe, so that my experience is mainly second-hand. It is sufficient, however, to point out some of the things that I shall do differently if I ever have another similar structure to design.

The standpipe was located on ground which a few years before had been filled about five feet deep with coral sand by the hydraulic process. The concrete bottom was made 18 in. thick,

*Clerk, Board of Trustees of Public Affairs, Milford, Ohio.
†Civil Engineer, United States Navy.

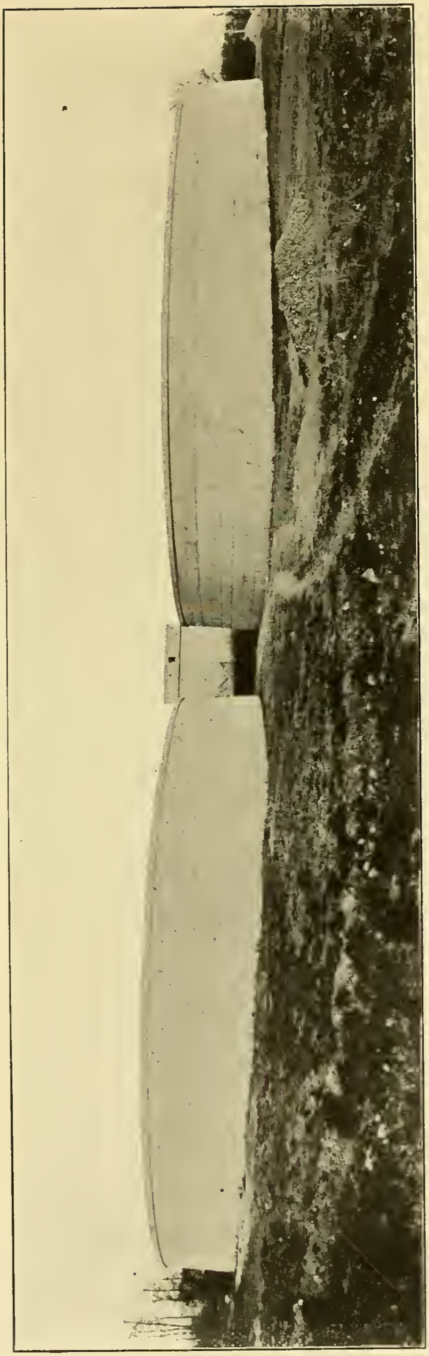
except under the standpipe wall, and was reinforced with four layers of heavy wire cloth. The upper 6 inches was of 1:2:4 concrete, the remainder of 1:3:6. No appreciable settlement was anticipated under the maximum load of less than one and one-half tons per square foot, but after completion and filling, a gradual settlement, averaging nearly 5 in., took place, the final maximum difference of level between the high and low sides being $2\frac{3}{4}$ in. This settlement apparently opened some considerable cracks in the bottom, but these seem to have been overcome with little difficulty. It probably would have been better if all the bottom concrete had been of the same mix and placed at one operation.

The standpipe wall is of 1:2:4 concrete, 12 in. thick for the lower 25 ft. The remainder is 8 in. thick. In the lower section there is a double set of reinforcing rods supported on 4-in. channels, spaced about 6 ft. 4 in. apart. These channels extended some distance into the foundation. The reinforcement in the upper section is single and supported on 2-in. angles. Splices in reinforcing rods were made by 2-ft. laps with three Crosby clips to each splice.

A proprietary waterproofing compound was mixed with the concrete under a guarantee that it would secure the desired degree of watertightness. The general opinion seems to be that the use of this material had absolutely no beneficial effect.

After the concreting was completed, but before any water had been placed in the standpipe, a crack was noticed which encircled the base of the cistern at the rigid connection with the side walls. This crack showed more on the outside than on the inside and was probably due to the contraction of the concrete in setting. When the standpipe was tested considerable leakage took place through this crack as well as through the foundation cracks previously referred to.

By the time the standpipe had been filled to a depth of 32 ft. the leakage had increased to the rate of about 6 000 gal. per day, and small leaks had appeared in the side walls near the base. The standpipe was then emptied, the large cracks covered with two layers of three-ply roofing, cemented together and to the concrete.



STANDPIPES AT BROCKTON, MASS.

The lower part of the side walls was painted with an elastic waterproofing paint.

The standpipe was then completely filled and a marked decrease in the amount of leakage was noted, but there was still considerable seepage from circumferential cracks marking the junctions of successive settings of the forms and from vertical cracks at practically every channel and angle to within 4 or 5 ft. of the top. The total leakage was now about 200 gal. per day.

Owing to the scarcity of fresh water, sea water was used for testing this standpipe. The seepage through the walls gradually lessened, as also did the remaining leaks at the base.

After a time the water was gradually lowered, the spots showing most leakage were gone over again with another coat of paint and additional protection given to the leaks in the bottom. As a result of this work the standpipe was made substantially watertight and has since remained so with practically no cost for maintenance.

The cost of the standpipe alone was $19 850. A roof was afterward placed over it at an additional cost of $4 994, making a total cost of $24 844.

ULTRA-VIOLET RAYS FOR WATER PURIFICATION.

BY M. VON RECKLINGHAUSEN, PH.D.

[*Read November 11, 1914.*]

We call *ultra-violet* the wave lengths produced by different Light sources which are shorter than the last visible violet rays. These wave-lengths have a strong bactericidal or, as we call it now, *abiotic* power.

We have to consider in relation to water purification two sources of these rays; namely, the natural source, the sun, which Duclaux calls "the cheapest disinfectant known," and the artificial sources of light, amongst which we have to consider mainly the electric arcs and sparks between metals and particularly the mercury vapor arc enclosed in fused rock crystal.

Some of the rays emitted by most light sources are distinctly favorable to life. I have in mind particularly the chlorophyll production which is going on only under the influence of daylight. Other rays, as above said, are harmful to life. It is, therefore, important in studying the influence of light on biologic phenomena to dissolve the light into its components, — that is to say, into its different wave-lengths, — and examine the effect of each one independently of any simultaneous action of any other wave-length; otherwise favorable and unfavorable actions may be superposed and thereby the image blurred.

The first to make such a biologic analysis of light was Ward, who threw the spectrum of an arc on an infected agar-plate. He found that on the violet end development of colonies was prevented, while on the red end the vitality of the germs contained on the plate was not impeded.

Another way to examine different parts of the spectrum is to use filters or screens which will allow light of certain wave-lengths only to pass. However, in this case we can only study the effect of groups of wave-lengths. I mention as particularly interesting for our case the filter consisting of colloidal silver solution in a quartz flask, which will absorb practically all the visible light and allow only a great part of the ultra-violet to pass.

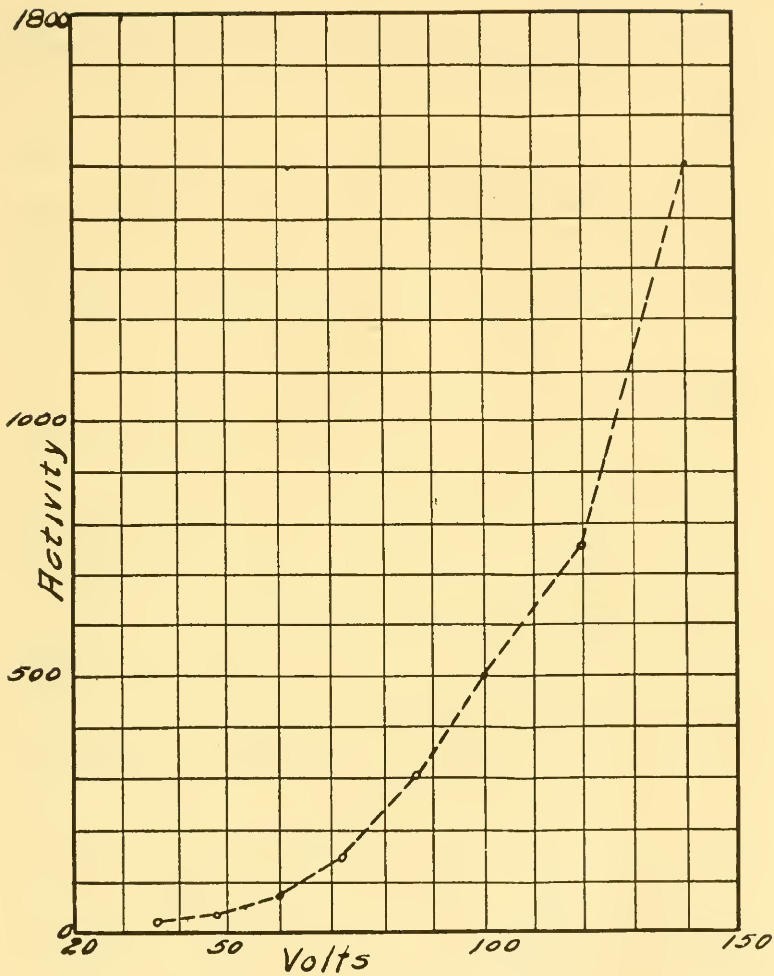


FIG. 1.

MEASURE OF ULTRA-VIOLET RAY ACTIVITY AT DIFFERENT VOLTAGES (TEMPERATURES) OF A QUARTZ LAMP.

Bang, one of Finsen's pupils, analyzed the spectrum as to its abiotic power. He found that wave-lengths of about .3μ are abiotic, while shorter wave-lengths were less powerful. In the work which Henri, Helbronner, and I carried on in Paris at the

Sorbonne University, and which forms the basis of this paper, we found that this does not hold true, but that it seems to be a strict law that the rays are the more abiotic the shorter their wave-length.

We can conclude, therefore, that a lamp will be the stronger in its abiotic effect, the richer it is in short wave-lengths.

The only industrial source of these rays is the mercury vapor quartz lamp, that is, a mercury arc enclosed in a fused rock-crystal tube. Such a lamp is a very simple instrument to handle, and burns on the usual distribution voltages, 110, 220, 500 volts direct current. On alternating-current lines the current must first be rectified in the usual way before going to the lamps.

The temperature at which such a lamp runs can be controlled by insertion of a proper amount of ballast resistance, by properly dimensioning of the tubes themselves, and particularly by removal of the excess heat at the electrodes by the creation of large electrode containers. We found that such a lamp will produce the more ultra-violet the hotter it is. (Fig. 1.) Of course this temperature has to be limited so that the heat will not affect the material of which the lamp is made; that is to say, we must keep the temperature below where the quartz will begin to desintegrate and become opaque to the rays. The temperature at which we obtain a rich production of ultra-violet rays during a period of many thousand hours without much falling off is about 700 deg. cent.; that is to say, considerably higher than the temper-

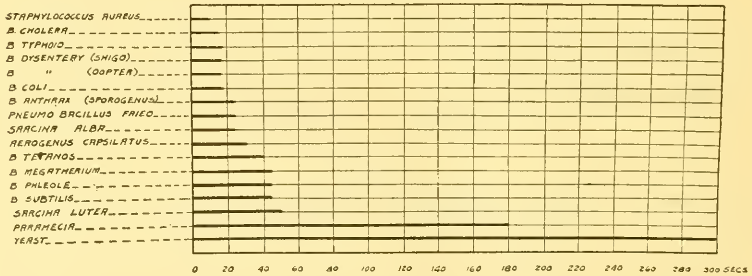


FIG. 2.

SECONDS NECESSARY TO KILL DIFFERENT TYPES OF GERMS AT 200 MILLIMETERS FROM A QUARTZ LAMP BURNING AT 66 VOLTS, 3.5 AMPERES.

ature of the water which we want to treat. It is evident, therefore, that the water must not come into direct contact with the luminous part of the lamp, so as not to reduce this favorable temperature, quite aside from other inconveniences created thereby. The way one proceeds is to burn the lamps above the water or in submerged chambers made of quartz, as will be shown later on.

We found in our experiments — and many others have confirmed — that germs vary in their resistivity against ultra-violet rays much less than in their resistivity against heat and chemicals, where some types show perhaps twenty times as much resistance as others. The table (Fig. 2) shows the relative resistivities of different types of germs.

Practically any solid substance which is opaque to visible light is also opaque to ultra-violet light. However, only a few substances which are transparent for visible light are also transparent for ultra-violet light. I mention quartz, fluorspar, water, and some salt solutions, which if colorless are nearly as transparent as air for the same rays. However, if colloids are in solution in the water, its transparency is affected, especially if these colloids are organic and colored. Physically the best waters, therefore, for submitting to the ultra-violet rays are those without colloids or color. In addition, they must be free from any solid matter in suspension; that is to say, if originally not clear, they must be submitted to filtration before being exposed to the rays. The freeing from suspended matter is a well-known problem and the solution is known. The removal of color is perhaps somewhat more difficult but this is not of equal importance for an ultimate treatment by ultra-violet rays. We have successfully sterilized water with color up to 40 on the United States scale. As to very finely divided mineral suspension, which ordinary filtration will often not remove, it acts, I think, like color in solution; that is to say, somewhat handicapping but not impeding the successful treatment by the rays. In practice, waters have been sterilized having turbidities up to 20 parts per million.

We must give the rays a chance to strike the germ during its passage through the illuminated zone. Therefore any suspensions which form shadows and allow the germ to be hidden from the light will have to be removed from the water. Of course

infected suspensions will be particularly dangerous as the germs may hide inside such material and thereby be perfectly safe from attack by the rays. All we need for a successful and at the same time economic sterilization by the rays is a naturally clear or well-filtered water. The amount of light used for the sterilization will depend on the amount of color or colloidal matter and fine turbidity left in solution by the filter. A physically perfect water will demand very little illumination for its sterilization.

However, as even the best filtration allows some minute solid material to pass through into the effluent, we found it advantageous to stir the water while passing it under the light and give thereby each particle a repeated illumination. For the same purpose we also try to repeat the illumination of the entire body of water several times by either leading it several times towards the same lamp or by passing it successively under several lamps. In this way all microscopic suspensions will surely be sterilized on all sides.

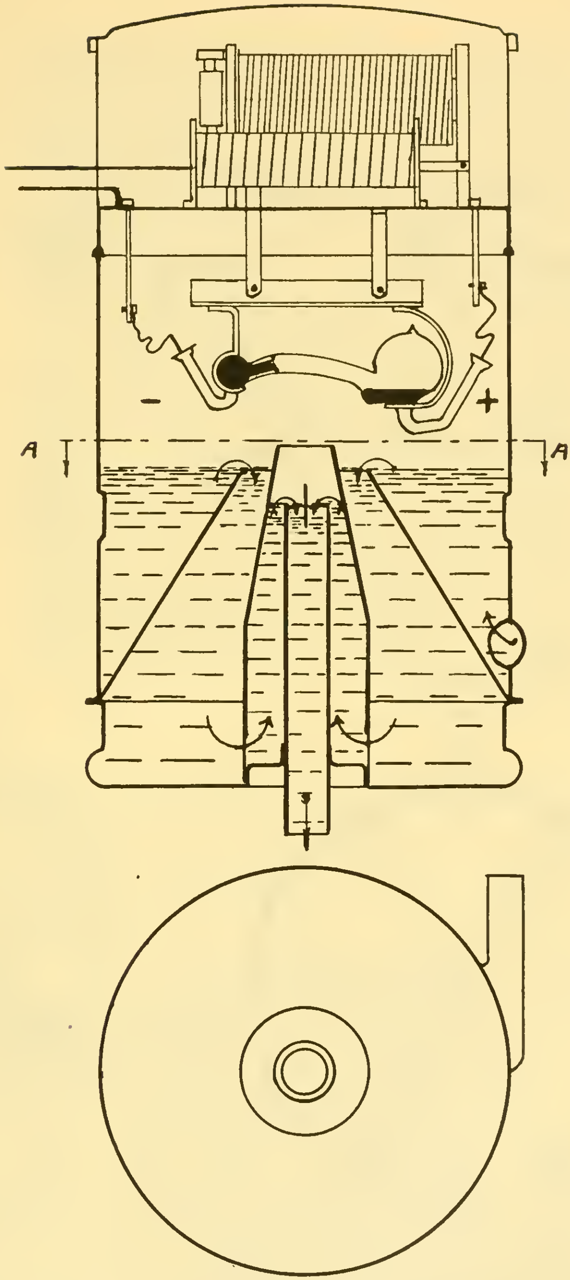
The stirring of the water during its illumination is done by inserting baffle plates inside the sterilization chamber, placing them of course so that they will form only the least shadow.

The sterilizing apparatus itself consists of a tank in which the water is lead through zones which are illuminated by mercury vapor quartz lamps. As mentioned before, the source of light must not be in direct contact with the water, because its cooling effect would impair the efficiency of the quartz lamps. For the sake of economy in light, it is better to use all the light coming from the lamp. In smaller apparatus one has to make sacrifices in this, as otherwise the apparatus would become cumbersome and expensive.

Such are, in short, the principles on which the ultra-violet ray sterilizing apparatus is built.

The following will serve to show some of the different types of apparatus.

In Type B2 Sterilizer (Fig. 3) the lamp with its electrode enlargements is suspended above the water. The water is submitted twice to the lamp, due to the cone-shaped baffles. The combination of circular and up-and-down flow results in stirring of the water during its passage through the apparatus. The output is up to 120 gal. per hour.



Section A-A

FIG. 3.

TYPE B2 WATER STERILIZER.

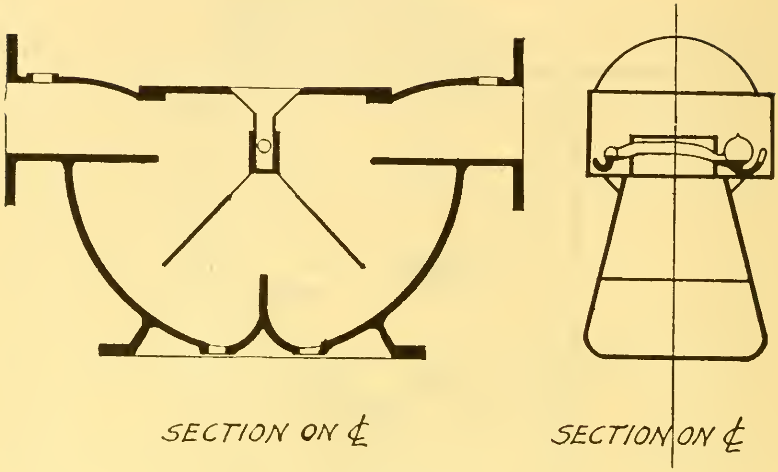


FIG. 4.
TYPE C3 WATER STERILIZER.

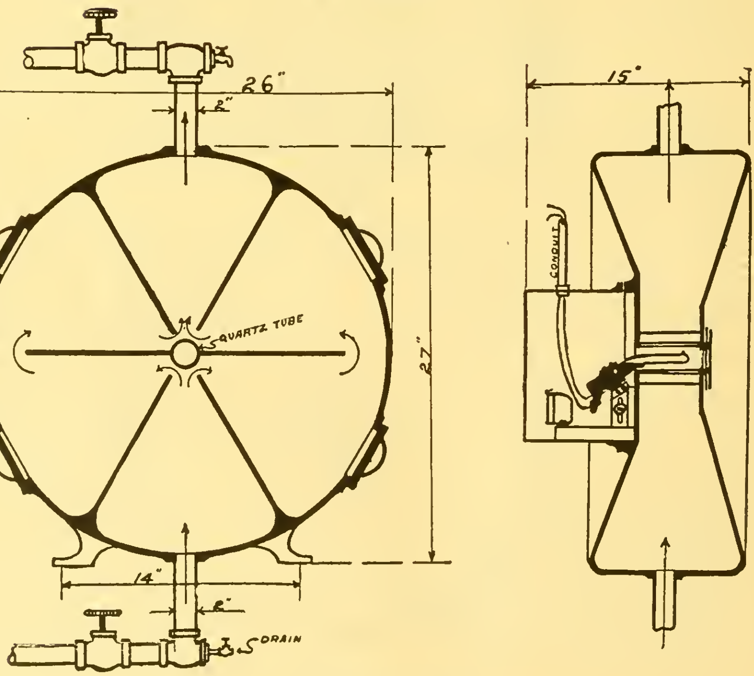


FIG. 5.
TYPE E PRESSURE APPARATUS.

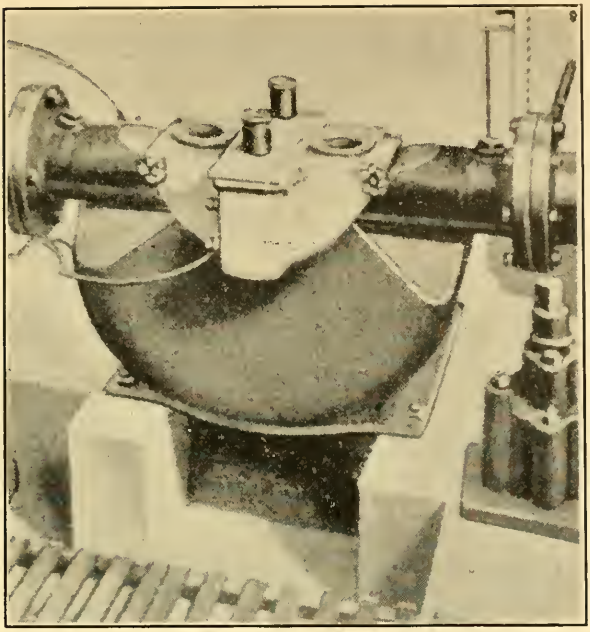


FIG. 1.
TYPE C3 WATER STERILIZER.

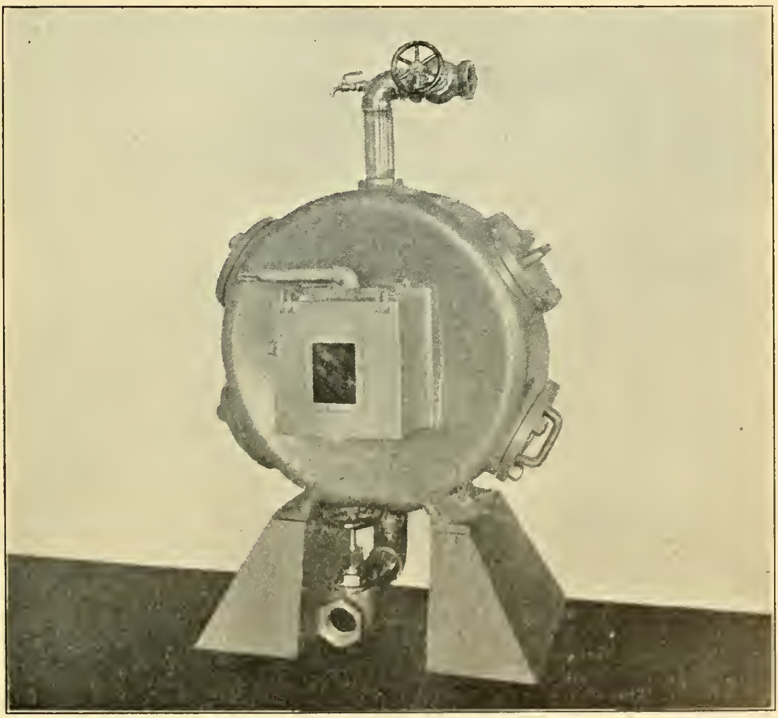
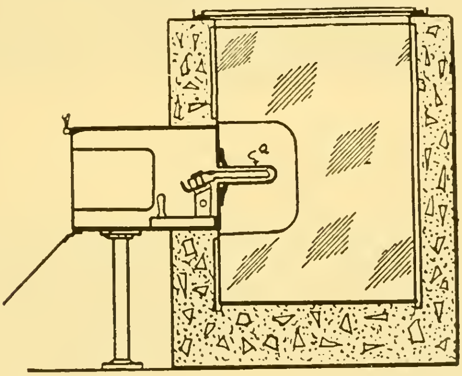


FIG. 2.
TYPE E PRESSURE STERILIZER.

In Type C3 Sterilizer (Fig. 4) the lamp with its electrode enlargements is suspended in a lamp box which has quartz windows. The water is lead three times towards the lamp. About 60 per cent. of the light of the lamp enters the water. The output is up to 6 000 gal. per hour. In Europe a good many of these apparatus are in service, some since 1910. (Plate XX, Fig. 1.)

To make use of all the light, we created the " Pistol " type lamp, which allows practically 90 per cent. of the light to enter the water. The chambers which protect the lamp from contact with the water are quartz tubes, which are inserted into the wall of the sterilizing tanks. The cumbersome electrode enlargements are kept outside the protective quartz tubes. The following types of apparatus use this method.

In Type E Pressure Sterilizer (Fig. 5 and Plate XX, Fig. 2) the



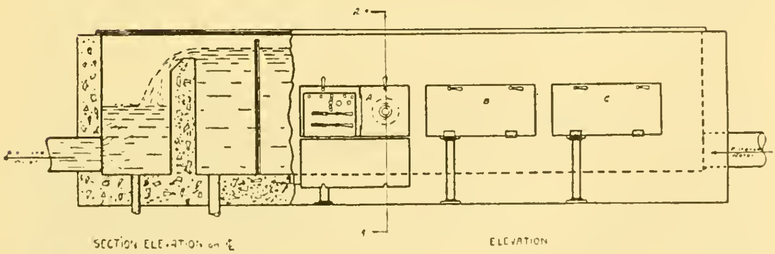


FIG. 6.
MULTIPLE LAMP FLUME.

water is brought near the lamp twice by means of the radial baffles, which also create stirring. The output is, according to the size of the lamp, 1 000, 2 000, or 3 000 gal. per hour.

. In the multiple pistol lamp-equipment of the flume type (Fig. 6) the luminous zones are created by one, two, or three lamps in a group. Several such luminous zones are created, through which the water has to pass successively. Baffles are placed opposite the lamps or lamp groups, giving the necessary stirring action.

There are many different ways that lamps may be placed: I show in Plate XXI, Fig. 1, a typical arrangement of two lamps along one side of a flume. Plate XXI, Fig. 2, shows the arrangement used in Luneville (France) where ten lamps are employed.

The bacteriological results of these plants are most satisfactory, and wherever we were able to obtain the hygienic results they prove the efficiency of the system in a remarkable manner.

In the following I want to give a series of remarkable bacteriological results obtained with some of the above described apparatus.

Type.	Before Sterilization, per cc.	After Sterilization, per cc.	Operator.
B2	8 000 2 840	0 .6	Westinghouse Laboratory.
B2	80 000 Sewage bacteria	0	Glaser, Austrian Army Medical Service.
B2	11 000 Sewage bacteria	12	Burgess, London.
B2	3 740 Sewage bacteria	0	Thresh & Beale, London.
B2	35 000 Coli communis	0	Jurist, New York.
B5	273 000 Sewage bacteria	0	Westinghouse Laboratory.
B5	25 000 Bact. typhosus	0	Philadelphia Clinical Laboratory.
C3	20 000 Sewage bacteria	0	Bengal Sanit. Committee.

To obtain results such as above it is important to examine the water for its physical quality before submitting it to the light of the lamp. A water may on superficial examination not reveal floating matter; it may be perfectly clear most of the time and give good results. At other times it may contain some few floating filaments, which got into it after filtration. They will, however, reveal themselves easily to the eye of the careful observer, if he

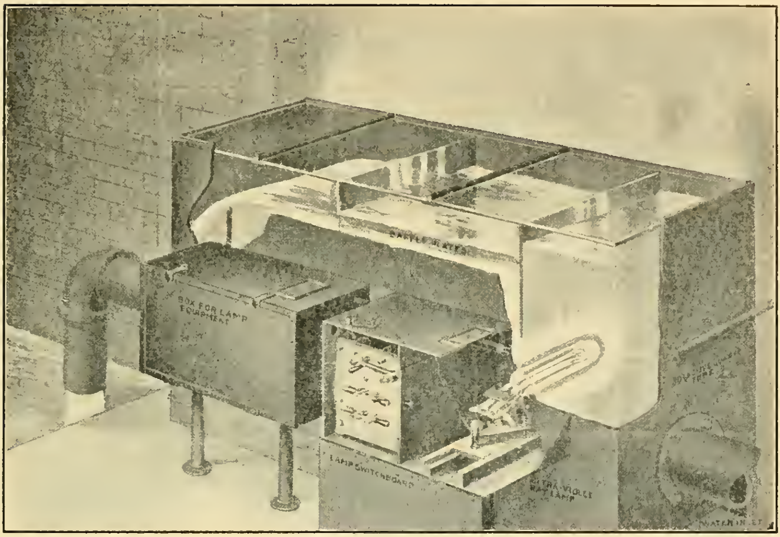


Fig. 1.
Two-Lamp Sterilizer Flume.
(By courtesy of the *Scientific American*.)

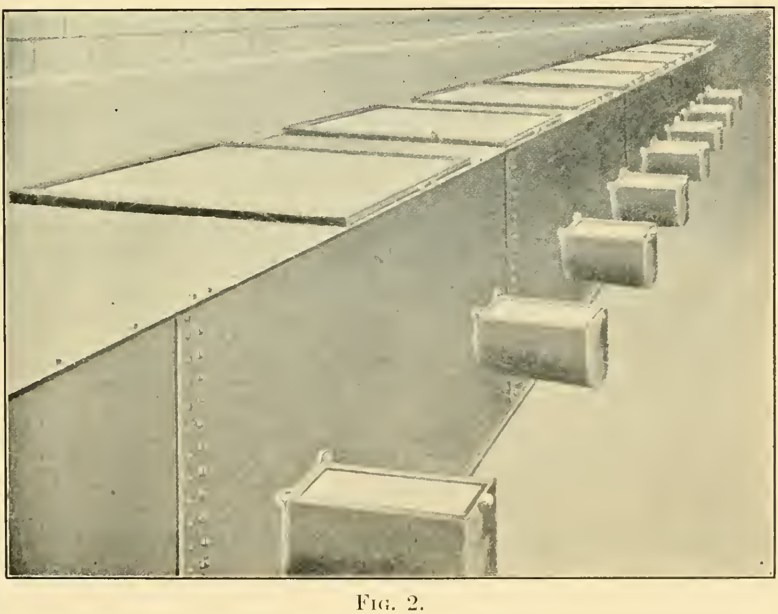


Fig. 2.
Ten-Lamp Sterilizer Flume.

takes the pains to look at the water under a strong light (sun or arc lamp) against a dark background. In my opinion the best proof for a slight amount of floating matter is a test like the above B2 test, where 12 germs escaped while 11 000 were killed. If the lamp is strong enough for 99.99 per cent., it must surely be strong enough to kill the other .01 per cent. provided they were not shielded during the passage of the water through the tank.

The consumption of electric energy for sterilization by the ultra-violet rays depends greatly on the size of the apparatus. In the types like B2 or B5 it may vary from 0.4 to 2.0 kw. hours per 100 gal. The only really economical apparatus are those with the Pistol type lamps, which are themselves powerful light sources and which are so constructed that the light is all used in the sterilizing chamber. On physically good water in large plants, less than 100 kw. hours will be needed per million gallons. This would include a large safety coefficient, allowing for falling off in candle-power and other contingencies. It will always be good, anyway, to use a large overdose of the sterilizing agent if we want to produce a water which is at all times hygienically safe, and provided no disagreeable result is created thereby. You all know that with chemical sterilization we always have to use only just enough of the chemical if we do not want to spoil the water and make it unfit for consumption.

The mercury lamps have a property which makes us very sure of their action during their entire life. As soon as they are worn out they begin to extinguish themselves frequently. The operator is therefore warned that he has to replace such lamps. He has merely to attend to a proper regulation when the lamps are put in service, which is easily done by means of the regulating rheostats. It is easy to arrange automatic water cut-offs for the care of spontaneous failures of the electric light plant. In case the water is of varying physical quality a little practice will soon teach the operator when he has to put more or less lamps in service. A simple checking of the color of the water on the color scale gives sufficient indication of the number of lamps needed.

An important point we have to consider in studying the economy of this system is the possibility of filtering at much greater speed than we are doing nowadays, because it is possible to overdose

to any desired extent, when using the rays as a sterilizing agent, a thing which is impossible with chemical sterilization, which always requires a more thorough removal of the bacterial contents before the disinfectant is added.

The simplicity of this system of sterilization is striking and also its close resemblance to Nature's way of abiotic action, — that is to say, the bacteria-killing action of the rays of the sun.

DISCUSSION.

MR. JOHN C. WHITNEY. Mr. President, I should like to ask Dr. von Recklinghausen if there are any plants in operation on a large commercial scale.

DR. VON RECKLINGHAUSEN. The industry has only been recently introduced in this country, and up to the present date only one public water-supply plant is in operation, although negotiations are under way for the installation of some large plants.

As to European plants, I can mention the Luneville city plant, which has been running since 1912, delivering about two million gallons per day. Another very much larger plant was under construction at the beginning of the war for the city supply of Genoa. Besides this there have been municipal plants in service for several years at Saint-Malo, Maromme, Isle-sur-Sorgue, and in other places.

THE PRESIDENT. I noticed something in the paper which interested me very greatly, namely, that the American Hospital in Paris was employing this method for all of the water used in their hospital.

MR. JOHN C. WHITNEY. Mr. President, I would like to ask the doctor as to the probable cost of operation on a fairly large scale.

DR. VON RECKLINGHAUSEN. As I mentioned before, the cost of operating on a fairly large scale depends upon the quality of the water. In a particular case which is under discussion now, I doubt whether the current consumption will exceed 100 kw. hours per million gallons, and as the cost of the kw. hour in that place is about one tenth of a cent, the current bill would be about ten cents per million gallons.

The lamps will have to be repumped from time to time, and it may be that one or the other vital parts of the lamp will have to be replaced. The cost of this can only be estimated. I think that a figure of between ten and thirty cents per million gallons will be conservative. The moment I have some actual data on hand, with lamps manufactured in this country, I will publish the same for general use.

Mr. Tannett. Mr. President, I would like to ask the doctor what would be the probable action of ice in the sterilization.

Dr. Recklinghausen. We found there is no difference at all in the sterilizing action for water from about 50 degrees centigrade downward; there was no difference either between cold water and tepid water. When we came to ice, we found that the speed of sterilization in ice was about the same as in cold water, provided that the ice is clearly frozen — that is to say, not spongy; I mean provided that it is a real solid, glass-like looking piece of ice. Under those conditions sterilization goes on just the same, provided of course that the water does not contain any suspended matter.

PERSONAL CHARACTER IN ITS RELATION TO PRACTICAL EFFICIENCY.

BY CHARLES H. EGLEE.

[*Read March 10, 1915.*]

Mr. President and Gentlemen, — During the past twenty-five years that I have been here with you, and about the country, I have noticed a very great change, not only in the personnel of this assembly but in various other directions, and I want to talk to you a little about the changes in business methods; not that I am going to say anything that is new, — nothing of the sort; all of the things which I expect to say are trite and very well known to you.

I must refer to the President's statement that the papers, the technical discussions, and the publications of this Society are so well thought of everywhere. I find quotations from the papers of the New England Water Works Association wherever I go, and I find that the reports of its committees are held in very excellent standing in all sections of the country. I believe that this Association is doing a splendid work, not only in its own community but everywhere that its influence reaches.

Once in a while you depart from these technical discussions and introduce subjects of a more general character, and this subject of which I am asked to speak to-day is of that kind.

The subject is " Efficiency in Its Relation to Character," — the efficiency that is so much talked of at the present time. Everywhere the cry is " Efficiency " because business to-day, — general business, and of that I speak, — general business is in an extreme state of confusion. We are losing our old standards of measurement; we are losing our old ideals and endeavoring to set up new ones. Practices that were prevalent and proper twenty or thirty years ago are no longer considered so; many of them are very seriously condemned, and often they are very gravely punished. To change the standard of measurement in a whole nation from

the narrow classification of the welfare of business to the broad foundation of the welfare of the entire community, and to do that without creating ill-will among the people, and without distress or bitterness, is a task that is fitted for the highest intellects of the land. Business is becoming enlightened, and we are finding that it is no longer a personal matter. It is a service that must be rendered to the community, and the man who renders the greatest service is the man who receives the greatest returns.

I am very sorry that our political leaders of the present day have set up a slogan of competition, rather than to have set up the cry of coöperation. We are all trying to coöperate, and in consequence men are growing better in their business. Associations of this character, boards of trade and chambers of commerce, are drawing men closer together. The past generation has been an era of big things, and we were training men to do big things; but while we trained those men we lost the proper standard. I do not suppose that there is a man in business to-day who was in business twenty-five years ago, whose face is not flushed with shame when he thinks of the things to which his own chosen profession descended at that time.

Everybody to-day is talking about Personality and Individuality and Efficiency. A great deal of attention is being paid to what a man can produce, and how he can be induced to produce it. Experts are developing in this direction, which would have been impossible twenty-five years ago. An endeavor is being made to take advantage of the reserve force, which the late Prof. William James, of Harvard, demonstrated is latent in every man. This reserve force has been brought out in times of stress or necessity, and is what the athletes call a man's "second wind." Experiments have proven that, with proper rest and proper conservation of this energy, a man's daily production can be largely increased without fatigue.

Mr. Frank Taylor has taught a common laborer how to move forty-seven tons of material in a day with less effort than he formerly used in moving thirteen tons.

Mr. Frank Gilbreth has taught a bricklayer how to lay brick with five motions of his body, instead of eighteen, which was formerly the case.

Mr. Harrington Emerson has with the same machinery and the same force of labor built five locomotives in the same time that was formerly required in building three locomotives.

Everywhere is this cry of "Efficiency." You cannot take up a magazine and turn to the advertising pages, but what you see there are various schools of "efficiency," all of them appealing to you to take courses in them. The trade union started the improvement in the first place. The trade union set up a high ideal. It said, "If we can get as much wages as possible for as short a period of work as possible, we will have all the rest of the time for improvement." That was their cry. The ideal was all right, but there was difficulty in the leadership.

You cannot get a man to improve himself unless you give him an incentive for that improvement. Efficiency not only means the highest product of the individual, but it means at the same time the highest improvement and prosperity of the individual. Merely securing high wages and short hours does not improve the individual character; some other motive is necessary.

Then came the efficiency engineer, with his stop-watch and with his motion study, and he demonstrated how a man could eliminate a lot of waste motion. He is doing a fine work, but he has learned that it will not do that a man shall be treated merely as a machine; it will not do that he shall be shown merely how he can produce, without at the same time inducing in him that spirit of self-improvement and that motive whereby he shall improve his own character and increase his own prosperity at the same time that he increases the prosperity of the product.

So there is a third efficiency engineer now coming into the field, and that is the man that we call the "humanitarian" engineer. He cares for the welfare of his people, and he shows his people how they can improve themselves personally and in that way improve their product. There are a good many examples of that sort of efficiency in the vicinity of this city. I suppose the most prominent example in the country to-day is at Dayton, Ohio, in the National Cash Register Company. That Company has a wonderful man and a wonderful personality at its head. You find one near here also, in that great organizer whose name is almost lost or merged in the United Shoe Machinery Company,

— Mr. Winslow. They are doing a splendid work in that company, and its influence is steadily growing stronger. The humanitarian engineer is coming to the front, because his work means the improvement of the individual and the improvement of character and personality, as the work progresses.

There has never been any time, probably, when a man had as great an opportunity to advance himself and to advance the interests of his community, of his neighborhood, or the world about him, as he has at the present time. We are emerging from a state of confusion, and the men who will be prominent in establishing better methods are the young men of strong personality and good principles; men who are educated to impress their individuality upon the people that they come in contact with. And these young men find that they are meeting with a great deal better class of men than those who were doing business twenty-five years ago. Men that are stronger and more sympathetic; broader-minded and more honest. They have been obliged to be honest. They have not only practiced honesty as a policy, but the people who surrounded them have forced them to do so.

This great movement of which we are speaking is a movement of the whole people. It is an outward expression of the awakening of the conscience of the people. And this conscience is demanding honesty in high places; equality of justice without regard to station in life. It is demanding also an equal opportunity for all men to expand. This expression of the conscience of the mass of the people is forcing honesty along lines that were never thought of before.

No business to-day that is founded on fraud can last; it will surely collapse when the force of public opinion beats upon it. We are realizing that big swindling schemes, profitable as they were to a very few individuals, have been nothing less than waste when viewed from the standpoint of the state. We know that poverty, crime, disease, inefficiency, and illiteracy are also a public waste; and that the taking of large sums of money from the people in an illegal manner, for the purpose of creating a group of multimillionaires, is no less a waste than is the waste of war. Men are better to-day, and we are finding an expression of that betterment in the laws that are being brought forward in all different directions.

All men are asking, "What are the qualifications that are necessary for a successful and efficient business man?" Those who have studied that question have come to the conclusion that there are two absolutely necessary qualities. There is nothing new in this statement; it is the thing that you all know yourselves. You know no man can be successful, unless he has these two qualities, the first of which is good health, and the second, good character — not to say that a man in poor health cannot achieve a good character, but that very few can. Our characters are dwarfed or warped by the limitations of our bodies, so that we cannot (or usually cannot) achieve sterling character in the face of poor health. The talk everywhere to-day is of good health. All sorts of systems are in operation for promoting good health. Health boards and various bacteriologists and sanitary experts are studying public health. But while we do this collectively, we neglect it individually. The rules of health are so simple that we forget about them. Every man can conserve the health that he has to-day. We may not be strong men, or athletes, but we can all use plain food, we can all exercise a little in the open air, and we can all get eight hours' sleep, and we can all cultivate a cheerful disposition. And with all these we can work hard. But late hours and gambling, the abuse of liquor and tobacco, low and debasing thoughts, and the society of some sorts of ladies, — all that sort of thing militates against good health and saps a man's energy. And energy to-day is what tells. There is no such thing as genius — genius is hard work. And the man who has got the best health is the man who is able to work hardest. There never was a time when the tennis court and the golf links, the gymnasiums and swimming pools were used as they are to-day, not only among young men but among the older men. I have a friend over sixty years of age who has just answered an advertisement in a magazine and is taking a course in home athletics. You know the system, — the one, two, three. It keeps his blood in circulation. He is over sixty years of age, and he says that he has benefited by the course so much in two weeks that he expects to live to be a hundred.

Good health is the foundation, the primary foundation, of a successful business career, — combined with good character. Two attributes of that are necessary also.

I suppose you think the first principle is honesty, but that is not so. Very often you will see a rogue successful where an honest man fails. The very first thing that a man must have is courage. Not the courage of a soldier, who in a moment of enthusiasm or in company of his fellows undertakes a hazardous enterprise; nor the courage that makes a man a hero in a critical situation or in a fight. That is not the courage that we are talking about. The greatest courage is that which takes up the little daily petty difficulties; the droppings that wear away the rock; the strain upon your nervous energy; the work you do for which you are not paid; the incompetence and the inefficiency of your employees; the pride and the arrogance and the overbearing manner of your employer. All these things are working against your courage the whole time. The man who faces these with resolution, or who overcomes them with a determined purpose, is going to succeed just simply by the force of his daily courage.

The courage that is thus trained, every single day, is not overcome by those earthquakes, those crises, those tremendous convulsions that always occur in every business life. Almost all the men who are listening to me now know what that is. You have all been up against it, and you know that if you had not had that courage, trained by the little petty annoyances of daily life, you never could have gone through with the big things.

Courage is a quality that grows upon us every day as we practice it; it is the greatest attribute that we can possess; it is the foundation of a successful business career.

With that sort of courage we must combine the element of faith. With these two, we overcome almost everything.

By faith, I mean, in the first place, faith in the proposition in which we are engaged. There is no use going into any sort of a proposition unless we have faith in it. Then we need faith in the people we are connected with in that proposition, and faith in ourselves. There is such a thing as conceit and overweaning egotism, which is very objectionable; but a quiet self-confidence,— a faith that we are able to achieve, a faith that we are able to go forward, a personal faith in ourselves,— that what man has done man can do, and we are just as good a man as another — if we go forth with that faith in ourselves, our courage will overcome every obstacle.

Then there is another kind of faith, and that is faith toward the people that we are associated with, and faith in our fellow-men. That is growing in the business life of to-day. It is a splendid thing to cultivate, for it makes us feel good, and if we feel good we can work hard. We ought to have this faith in the other fellow, believing that he is doing as well as he knows how. He may not be doing it just exactly our way; in fact, he may have a better way. We have no standard for judging him, and so we ought to have a good deal of faith in him.

With these two qualities at the foundation, there are other traits of character that emanate from them. And the first is loyalty. I should like to talk a lot about loyalty. We need loyalty to the proposition, loyalty to the house. We ought to get that right down to the foundation of our system in the first place, and then believe that the people associated with us are also loyal, and are working together in coöperation. So many men think that if they work hard and earn their salary this is all that is expected of them, and if there is any excuse for it they are forever criticizing their orders, kicking about the management, and sowing seeds of discontent wherever they can. This is not an example of loyalty, but it is the worst sort of disloyalty, and employees that are doing that sort of thing, just as sure as they are born, are getting themselves ready for the toboggan. But why shouldn't they? Almost every employer is complaining about the disloyalty of his employees. Where is the employer that is loyal to his helpers? When you are directing other men, are you showing them an example of loyalty? Do you believe in them? Do you believe that they are doing the best that they are capable of to-day? Do you believe in the boys? Are you showing them how to be loyal to you? When your bookkeeper at the end of the month hands you the usual statement and you look at it and see three or four errors, the first thing, what do you do? Scold, curse, and complain? Do you stop to think that the man may have been sitting up all night with a sick wife? Do you care whether he has any wife or not? How loyal are you to that employee who is working for you and for the interests of the firm the best he knows how? He isn't as good as you are, — if he were he would be in your position and you perhaps would be working for him.

I was buying an overcoat, the other day. It was a large salesroom, with thirty or forty salesmen on the floor, and I was talking with the salesman that I had dealt with for several years and who thinks a good deal about efficiency. He writes sometimes for the papers about efficiency. I said to him, as I looked over the floor: "If all these men here were only loyal, if they were only coöperating, if they were only strong for the firm, instead of coming down here every morning and kicking and growling!" "Why," he said, "how did you happen to put your finger on the very worst feature of this whole establishment?" "My dear sir, simply because it is the worst feature of every establishment." "Why," he said, "these fellows on this floor are the worst sort of kickers, the worst sort of growlers!" And I said to him: "What are you doing? Are you one of the same sort? Are you talking the same way? Here you are telling me the worst feature of your establishment, and I am a stranger. What are you doing to change all this?"

We think a great deal about this quality of loyalty, mostly in criticism of others, but when we think about it again, let us also think: "What am I doing myself? What is my individual attitude?"

Now, of course if a man has all these traits he has got to be honest, not only in money matters, or not particularly in money matters — the law will take care of that. He must be honest in other directions also. Are we honestly doing our work, and are we honestly seeing that those for whom we are responsible honestly do theirs? We are not. I do not suppose that there is any man, any average man, who honestly strives every day to rank high in the scale of efficiency and honestly give out to the world the very best that is in him. No. We are usually too lazy! We are working up to the day of the pay envelope. We are working just so that we get by.

I was in the office of the manager of a big department store here in Boston, the other day, — a man whose day is crowded every minute; and he has over his desk a big motto which says, "How lazy do you dare to be?" That is the great trouble with most of us, — to be honest with ourselves. The man who learns how to be honest to himself cannot help but be honest to other people.

Now, suppose we have all this courage and faith and persistency and loyalty, and all the rest of it. The question is: Do we make money? Not necessarily, gentlemen! Money is not made by the exercise of any of these qualities. Money is made by the exercise of the supreme quality, — originality; or what the efficiency expert is calling to-day "initiative." Initiative is doing the thing without being told. It is finding a short cut to the result. It is instituting an economy that is new. It is discovering something that no one has discovered before. It is being first in any movement. "Initiative" — that is the great money-making quality. And if a man has this quality and combines with it the faculty of managing men, that man is bound to make money. It doesn't matter whether he is an honest man or a rogue. But he makes money more easily if he combines with initiative these other good qualities. If we have initiative to the highest extent we are at the head of the Steel Trust. If we haven't it to quite so great an extent, we are at the head of some other enterprise.

So, if we are going to be successful, — and I am not speaking only to the active members of the New England Water Works Association, but to the salesmen that meet here, — if we are going to be successful in the world, we cannot enter into business in any haphazard sort of way. We must study ourselves, our habits, and our disposition, and endeavor to get into some sort of work where we can expand along natural lines. That is very difficult, — the fitting the right man to the right place. There is no system at the present time here to do this. In Germany they have perfected efficiency to such an extent that they claim there are only two per cent. of men who are in the list of the absolutely inefficient, and here in this country we have eighteen per cent. constantly no good, — commercial defectives; eighteen per cent. in this country, and they have ciphered it down in Germany to only two per cent., simply because we have no method. Many a man is in Wall Street who ought to be a farmer, and many a man is an engineer who is a very poor engineer but who would make an excellent lawyer. We have our world full of round pegs trying to fit square holes. And what are we doing about it? We are beginning to think about it.

Dr. Blackford is trying a system at the Sturtevant Blower

Works. A system for testing the temperament and qualifications of applicants for work, whereby it may be discovered whether a man is fitted to any certain position. It is not to be absolutely relied upon, but is a long way in advance of any other method. It is a beginning along these lines. How are we going to fit that man to the job? That is what the efficiency engineer is trying to do to-day. He must, in the first place, improve himself. He must educate himself and then educate other men so that these may bring along the men who are not educated, that this tremendous waste of human material shall be done away with. The day may come when we will no longer have eighteen per cent. of business defectives in this country. Perhaps we may even be some day as good as the Germans.

We advance by studying ourselves. The greatest American that ever lived understood this. I refer to Benjamin Franklin. He studied himself all through his life. He kept a little memorandum book and he wrote down every day an analysis of his time and what he did with it. He would take a whole month to eliminate a particular fault in his character. He would study that one fault until he had eradicated it. Then he would take another month to train himself in some good quality that he had observed in somebody else. All his life he did that. And see what tremendous results he achieved from the initiative latent within him; he didn't know he had it. It is latent in every one of us, and we never know it until we begin this self study. It is the province and the benefit of the efficiency engineer, that he is waking us all up individually, and the work is simple if we can get away from that depressing laziness. Every man can train himself, and the results of that personal study one day are going to be manifest. They not only elevate him, they elevate everyone he comes in contact with.

We know that this nation can make no advance whatever except the units — we units — advance as individuals. When we put into the background honor and integrity, and bring forward nothing but the game of grab and the principle of every man for himself, we are not going forward, we are distinctly going backward; and as we go back, we hold back the advancement of the civilization of this entire nation. When we neglect our individual

responsibility as a citizen, when we no longer attend the caucus, when we let somebody else go to the polling booth in our place, we are holding back the advancement of our community because we do away with our individual responsibility as a citizen. And so we do as a business man in exactly the same way.

The efficiency engineer is improving this. The best thing that he seems to have done at the present time is to have eliminated waste motion. In that he has done a very valuable work, for the value of time has never been considered in a scientific manner before. Everybody thinks he works hard, and that he must spend a certain amount of time to rest from fatigue. You go home at night and say you have put in such a hard day's work, when you haven't really done any such thing; you will find if you analyse your day that perhaps one half of the time has been wasted in foolish and erratic movements. Put a fly in a bottle and he will tire himself out, but what will he accomplish? And that is the way a great many of us do, because we have never trained ourselves with a scientific mind to observe the conditions of our own individual career. We would rather tell somebody else what to do than try and practice that very same thing in our own business and in our own phase of life. I cannot impress too strongly this question of laziness.

We are all trying to make money, trying to make it too fast. Is it the greatest consideration in life? I suppose it isn't the first consideration in life, but it is a very happy state of mind to be in, —that making of money. We are all working for it, but I do not believe that we are working merely to make money. We are working for peace of mind. It isn't the acquisition of money or power or knowledge or place, that is the end we seek, it is the peace. And we are saving up for our old age so that we shall at that time be at peace. But there is no peace, and there never will be any peace, until every man understands his absolute individual responsibility for his own life, and trains himself, — at least trains himself as carefully as he is trying to train his little six-year-old boy. And he cannot train himself any better than in this game of business, — I do not care in what branch he is engaged. For the game of business is a very great game. It is a wonderful game. There is more fun in it, there is more pure joy in it, there is more

development in it, than in any game that a man can play. At any rate, we spend more than half of our time in it, and if we cannot get joy in life out of our business where in the world can we get it? It is the joy of creation, it is the joy of doing something with our own hands, — just like that little six-year-old boy who takes his saw and his hammer and his little tools and brings you something that he has made himself.

The creative instinct is the foundation of the race, it is the ineradicable instinct, — reproduction, and from that production. We love to produce, we love to build, we love to make things with our own hands. And we do that in our business.

We cannot make a success in it unless we work hard. It takes a good many years of study to learn how to do any one thing well; and no substitute for hard work has been found in a great many thousand years — not one. But, if you know when and where and how to place reliance upon a man, you are a genius. If you can supervise and regulate and delegate and keep discipline out of sight, you are a wonder. If you can take a tabulated statement at the end of the month and let it show the result of your department, and keep your hands off the details, you are a great man. And more than that, if you can take a force of uneducated, unregulated, undisciplined men, and train them to do the work that you want done, and keep them good-natured on small pay, why, you are the man to whom we take off our hat. You learn that in business. You learn it first by the development of your own character, and you learn it by study — whether you know it or not — you learn it by the study of these great principles, — courage and faith, loyalty, persistency and honesty. And that, with your "initiative," gentlemen, places you in the enviable positions that you now occupy.

PROCEEDINGS.

Hotel Brunswick,
Boston, Mass., March 10, 1915.

President Leonard Metcalf in the chair.

The following members and guests were present:

Honorary Members.

Albert S. Glover, Frank E. Hall.

Members.

R. C. Allen, J. M. Anderson, C. L. Baker, L. M. Bancroft, G. W. Batchelder, A. E. Blackmer, C. A. Bogardus, George Bowers, E. C. Brooks, James Burnie, J. M. Caird, G. A. Carpenter, George Cassell, J. C. Chase, H. S. Clark, H. W. Clark, J. E. Conley, J. H. Cook, C. E. Davis, J. M. Diven, John Doyle, E. R. Dyer, H. P. Eddy, C. H. Eglee, E. D. Eldredge, F. F. Forbes, S. F. Ferguson, Patrick Gear, J. W. Graham, H. J. Goodale, R. K. Hale, F. E. Hall, J. O. Hall, A. R. Hathaway, D. A. Heffernan, D. J. Higgins, J. L. Howard, A. C. Howes, W. S. Johnson, J. W. Kay, E. W. Kent, Willard Kent, S. E. Killam, C. F. Knowlton, W. T. Lenehan, F. A. McInnes, Thomas McKenzie, J. N. McKernan, Hugh McLean, A. E. Martin, W. H. McMahon, W. E. Maybury, John Mayo, F. E. Merrill, G. F. Merrill, Leonard Metcalf, H. A. Miller, William Naylor, F. L. Northrop, T. A. Peirce, H. E. Perry, J. J. Prindiville, L. C. Robinson, B. M. Rockwood, C. M. Saville, A. L. Sawyer, C. W. Sherman, E. C. Sherman, G. H. Snell, G. A. Stacy, G. T. Staples, W. F. Sullivan, H. A. Symonds, L. D. Thorpe, A. H. Tillson, E. J. Titcomb, W. H. Vaughn, Percy Warren, R. S. Weston, W. J. Wetherbee, G. C. Whipple, G. E. Winslow, I. S. Wood, Eugene Carpenter, H. B. Andrews, Carleton Scott, W. J. Turnbull. — 87.

Associates.

Builders Iron Foundry, by F. N. Connet and A. B. Coulters; Chapman Valve Mfg. Co., by J. J. Hartigan; Darling Pump & Mfg. Co., Ltd., by H. A. Snyder; *Engineering Record*, by I. S. Holbrook; A. M. Byers Co., by H. F. Fiske; Hayes Machinery Company, by F. H. Hayes; Hersey Mfg. Co., by A. S. Glover and W. A. Hersey; Lead Lined Iron Pipe Co., by T. W. Dwyer; Ludlow Valve Mfg. Co., by A. R. Taylor; H. Mueller Mfg. Co., by G. A. Caldwell; National Meter Co., by J. G. Lufkin and H. L. Weston; Neptune Meter Co.,

by H. H. Kinsey; Norwood Engineering Co., by H. W. Hosford; Pittsburgh Meter Company, by V. E. Arnold and J. W. Turner; Macbee Cement Lined Pipe Co., by J. D. MacBride; Rensselaer Valve Co., by C. L. Brown; A. P. Smith Mfg. Co., by F. L. Northrop; Standard Cast Iron Pipe & Foundry Co., by W. F. Woodburn; Thomson Meter Co., by E. M. Shedd; Union Water Meter Co., by E. K. Otis and F. E. Hall; Water Works Equipment Co., by W. H. VanWinkle; R. D. Wood & Co., by H. M. Simmons; Henry R. Worthington, by Samuel Harrison. — 28.

Guests.

Joseph E. Perry, Portland, Me.; H. E. Reynolds, Barre, Vt.; John Kelley, water commissioner, Braintree; F. M. Bates, DeWitt C. Webb, Boston; G. A. Stowers, Billerica; Joseph Weeks and E. A. MacMaster, Bridgewater; Herbert F. Conant, Attleboro; John H. Woods, S. J. Wright, and Dr. W. J. Powers, Holyoke; Mr. Mahoney and Mr. Newsholme, Methuen; John J. Pearson, Middleboro; Dr. Edward Bartlett, George H. Leland, Providence, R. I.; George W. Woodward, Westerly, R. I.; M. L. Miller, Springfield; Mr. Cullen, Woonsocket, R. I.; Mr. Maynard, Mr. F. W. Tucker. — 22.

The President. Before beginning the exercises of the afternoon, I want to say just a brief word to you in recognition of what you have done for me, gentlemen. For I count it one of the greatest honors that has ever come to me, that of being elected President of this Association.

I think that all of you would have been very much pleased if you could have heard some of the opinions that I have heard expressed during the past two years, in the Far West, in regard to the work of this Association. Its work is as well known on the Pacific coast as it is on the Eastern coast. Many men have I heard say: "We fear that we can never attend a meeting of the New England Water Works Association, but we value greatly the publications which it has issued." They recognize the worth of those publications, the work of your committees, the record which the Association has made for itself.

I can only say to you that, so far as I personally am concerned, I shall do the best that lies in me to further the interests of the Association, relying upon your good help in such ways as you can assist me — and there are many ways in which you can assist me — in furthering the interests of the society this year.

As I look around me, I realize what a real fund of information

there is stored in the heads of the various men seated about these tables. I feel that I am very much in the position of a judge of whom the story was told in California, not long ago, who was hearing a case against some Chinamen that had been brought before him. They were honorable citizens; they had gotten into some difficulty, — I don't know just what, — but the judge, feeling that he couldn't get information from them except through an interpreter, had to call to his aid such a man. The situation became more and more difficult. He knew favorably one of the men who was testifying before him, but he felt that he wasn't getting at the root of the matter. Finally he turned to the interpreter and asked him to ask his friend what he could do to get the Chinamen to tell the whole truth, to tell what they knew, and what the matter was with the way in which he was conducting the trial. The instant reply was that they didn't respect Uncle Sam's oath, and they hadn't been sworn in the proper way. So he said: "Very well, we will swear them in the proper way. What should we do?" The interpreter told the judge what to do, and, followed by the Chinamen, he started out into the back yard, where a rooster was caught and its head cut off, and the Chinamen had to take an oath as the blood dripped from the neck of the headless rooster. This was done with the utmost ceremony. The procession filed back again into the court room, and the proceedings went on, but again the judge was conscious that he was getting no nearer the truth than he had under the former conditions. He was very much disgusted, but he had to give up his efforts. After the trial was over and the men had been acquitted, the judge said to his friend: "John, what was the matter; why didn't the China boys tell the truth after we had sworn them in that way?" The man's instant reply was: "The trouble is, your lordship, you no cut 'em off head de light way!" [*Laughter.*]

Now, it remains to be seen whether I can succeed in getting your assistance by cutting off your heads the right way, or at least by tapping the fund of information that lies in them.

The Secretary presented applications for membership, duly recommended and endorsed, from John Cullen, Woonsocket, R. I., foreman of the Woonsocket Water Works for thirty years;

Calvin L. Baker, Abington, Mass., superintendent of Abington Water Works.

On motion of Mr. Frank L. Pierce, the Secretary was directed to cast one ballot in favor of the admission of the applicants, and he having done so they were declared duly elected members of the Association.

The President. I will make one announcement on the suggested committee upon "Service Pipe." I will appoint Mr. William S. Johnson, Mr. Harry W. Clark, Mr. George A. Stacy, Mr. William F. Sullivan, and Mr. A. E. Martin.

It has been suggested that, as amplifying the work of the committee which has recently reported upon "Meter Rates," it would be wise for the Association to appoint a committee, or to continue the work of the committee along the line of making an investigation of the water unaccounted for or lost in leakage; that that question also is involved in the meter rates, and that it would be desirable to secure more data, more exact information, than we have upon it.

Do you care to give consideration to that matter? I may add that the Executive Committee thought that it would be of advantage to make such an investigation. Does any one care to make a motion in regard to the matter?

Mr. George A. Stacy. Mr. President, I believe it is important that the committee continue that investigation as you suggest. I think accounting for the water is a vital principle, and that this is a proper problem to solve. If the Association continues this matter it will be doing a good work.

The President. It is moved and seconded that the committee which reported upon "Meter Rates" be asked to continue and to extend this work to the extent of making investigation concerning water lost in leakage, by non-registration of meters or otherwise.

The President put the motion, and declared it unanimously adopted.

The President. I will make announcement that the Executive Committee took up again this morning the question of place for holding the next convention, in response to some difference of opinion which had been urged upon this question. After careful

consideration and discussion, the board voted to rescind its previous action, and New York City was selected as the place for the holding of the next convention.

Is there any other business to come before the meeting?

Mr. William F. Sullivan. Mr. President, there is one matter that we took up at the last meeting, in regard to an invitation to the members of the American Water Works Association to join with us.

The President. As announced upon the circular, the question was discussed by the Executive Committee at the February meeting, and it was then voted "that initiation fees be remitted to members and associates of the American Water Works Association applying for admission to the New England Water Works Association during the year 1915." In order that the membership at large might have an opportunity to express its opinion as to the desirability of this, the Executive Committee has caused notice to be made of it upon this circular. The floor is now open for discussion or for comment.

Mr. Charles W. Sherman. I don't know, Mr. President, that there is need to say very much on this matter. Probably most of us know that for more than a year past the American Water Works Association has extended the courtesy of admission to its membership to members of this Association without paying an initiation fee, and it is no more than fair that we should do the same thing for them. The associations, while rivals to some extent, are supplementing each other's work to a considerable degree, and a large portion of the members of each Association could with great advantage be members of both. With that in view, the Executive Committee at the February meeting passed this vote, under which, if approved by the Association, the members of the American Water Works Association when elected to membership in this Association can become members without paying an entrance fee. But we felt that this step was so different from anything that had been done heretofore that we did not care to put it into effect without submitting it to the Association for approval, with notice of that proposed action going on the circular.

In order that the matter may be discussed and the opinion of

the meeting arrived at, I will move that the action of the Executive Committee in passing this vote be approved by the meeting.

Mr. Charles H. Eglee seconded the motion.

Mr. William F. Sullivan. Mr. President, should this not be an amendment of our By-Laws?

The President. I think not, sir. At least I would so rule. Is it your view that it is in conflict with the By-Laws?

Mr. Sullivan. Yes, Mr. President, that is my view. But I am not sure of it. We have got the By-Laws here.

The President. To which by-law did you refer, Mr. Sullivan?

Mr. Sullivan. The section in regard to "Dues."

The President. Well, but does that prevent the Association from abating the dues for a certain limited period?

Mr. Sullivan. At the February meeting this came up before the Executive Committee. The Executive Committee discussed it, and in looking over the By-Laws at that time I was given the impression that this was a matter of amendment to the By-Laws. And that is why this written notice was given to the members here to-day, as the By-Laws provide that on any proposed change of by-laws such notice shall be sent to the members.

The President. Oh, you mean the occasion for putting it in the circular?

Mr. Sullivan. No, in order to be able to remit dues, to admit members without paying the initiation fees, you have to change your By-Laws.

Mr. Merrill. Mr. President, under Article III of the By-Laws, the last part of Section 1, it states: "All applications for membership presented to the Association for action must be accompanied by the proper initiation fee and dues for whole or fractional part of current year in which application is presented." So that this action will necessitate an amendment, I should think.

Mr. Sherman. Mr. President, I examined the Constitution pretty carefully in view of this action, and while I do not pretend to be a constitutional lawyer, I could not see anything that would prevent the Association from abating any fees or dues that they might see fit to abate.

Mr. Sullivan. I think so, too, Mr. President, but the im-

pression I obtained at the Executive Committee meeting was that it was an amendment of the By-Laws, and that is why we notified the members in writing.

The President. I would say to the members that I read these sections over, and it had not seemed to me personally that there was anything in them which would prevent the Association, after due action of the Executive Committee and due notification, which has now been had, from taking any such action. You are not doing away with the custom of charging an entrance fee; you are merely abating it to a certain class for certain good reasons, which the membership it seems to me has a perfect right to determine. The Chair would so rule, unless there is opposition and you wish to have that question put.

Mr. J. M. Diven. Mr. President, does the Constitution defining the duties of the Executive Committee give them that power? I haven't a copy of the Constitution with me.

The President. In answer to that, Mr. Diven, I would say that it seemed to us that it does give them that power.

Mr. Diven. Mr. President, what is a little thing like the Constitution between friends? [*Laughter.*] Every water-works man in the country ought to be a member of both Associations. I think that at the present time there are about three hundred interlocking members, but that interlocking membership ought to apply to the entire membership of both the Water Works Associations in the country. There is no water-works man in the country who can afford not to be a member of both Associations and have their reports in his library.

The President put the motion for the amendment and it was unanimously adopted.

The first topic for the afternoon was the Discussion of the Report of Committee on Filter Statistics, Prof. George C. Whipple, chairman. The discussion was opened by Mr. William S. Johnson, consulting engineer, Boston, who also made a motion, which was seconded by Mr. Eglee and unanimously adopted, that the last recommendation of the committee (that it be continued for another year) be carried out, and the existence of the Committee on Statistics of Water Purification was accordingly extended for another year. The following named gentlemen also participated

in the discussion of this report: James M. Caird, Carleton E. Davis, and Harry W. Clark.

"Personal Character in Its Relation to Practical Efficiency" was the subject of an address by Mr. Charles H. Eglee, of the Aberthaw Construction Company, Boston.

Mr. Francis W. Dean. Mr. President, I think we ought to present a vote of thanks to Mr. Eglee for this talk, for I am free to say that it is the best talk of the kind that I have ever heard in my whole life. I move, therefore, that we give him a vote of thanks.

The President. It is moved and seconded that a vote of thanks be given to Mr. Eglee for his exceedingly interesting talk.

The motion was unanimously adopted.

Mr. Eglee. I thank you, gentlemen. I thank you because it comes from men, as I said before, whom I have been associated with and intimate with and grown up among for the past twenty-five years, or more, perhaps.

The President. I am sure every man here feels that while the subject which Mr. Eglee has treated is old as the sun, and the subject is trite, perhaps, yet he has clothed it in a most interesting way. He speaks with the authority of a man who has himself achieved results.

The Topical Discussion upon "Concrete Standpipes" was opened by the President, and Mr. Thomas McKenzie, engineer of Westerly Water Works, followed with a paper illustrated with slides. Mr. Herbert F. Conant, of Attleboro, followed with a paper descriptive of the repairs to the Attleboro standpipe. Others who took part in the discussion were Mr. H. B. Andrews; Mr. Frank A. Marston, who showed slides of various standpipes; Mr. Bertram Brewer, Mr. Raymond C. Allen, Mr. Francis W. Dean, Mr. William S. Johnson, and Mr. Simpson of Simpson Bros.

The President announced that he had received one or two letters and papers, including one from Mr. D. C. Webb, civil engineer of the navy, but that in view of the lateness of the hour they would be published in the columns of the Journal instead of being read at that time.

EXECUTIVE COMMITTEE.

Meeting of Executive Committee of the New England Water Works Association at headquarters, Tremont Temple, Boston, Wednesday, March 10, 1915.

Present, President Leonard Metcalf, members Carleton E. Davis, George F. Merrill, Caleb M. Saville, Charles W. Sherman, William F. Sullivan, Edwin C. Brooks, Samuel E. Killam, George W. Batchelder, Willard Kent, Richard K. Hale, Lewis M. Bancroft, and Past President Frank A. McInnes.

Applications for membership were received from Calvin L. Baker, superintendent water works, Abington, Mass., and John Cullen, foreman water works, Woonsocket, R. I., and were, by unanimous vote, recommended therefor.

A communication with reference to lecture on waterproofing was referred to the President, with power to act.

A general discussion of the subject of place for holding next annual convention was had, after which it was voted to rescind the vote "that the next annual convention be held at the White Mountains," passed at a special meeting of the Executive Committee held December 26, 1914.

On motion of Mr. Batchelder, seconded by Mr. Merrill, it was voted "that the next annual convention of the New England Water Works Association be held in New York City."

The President was, by vote, authorized to appoint a committee on increased membership and a committee on June meeting.

Adjourned.

Willard Kent, *Secretary.*

Meeting of the Executive Committee of the New England Water Works Association at headquarters, Tremont Temple, Boston, Mass., May 7, 1915, pursuant to call of the President.

Present: William F. Sullivan, Caleb M. Saville, Charles W.

Sherman, Edwin C. Brooks, Samuel E. Killam, George W. Batchelder, Willard Kent, Richard K. Hale, Lewis M. Bancroft, George A. King, Frank A. Barbour, and F. A. McInnes.

Messrs. McInnes, Sherman, and Barbour, the committee appointed December 26, 1914, to consider the question of raising funds for future conventions, reported the following recommendations, viz.:

1. The general arrangements for the Convention, including hotel arrangements, program of papers, and program of entertainments, shall be in the hands of an Entertainment Committee, to be appointed by the President.

2. The exhibits by Associates shall be in charge of a Committee on Exhibits, the chairman and a majority of the members of which shall be representatives of Associates of the New England Water Works Association. This committee shall have full charge of all arrangements for exhibits, with authority to assess the exhibition cost among the exhibitors.

3. The fund offered for the entertainment of the Convention (being exclusive of the Convention exhibit costs) by the Water Works Manufacturers' Association shall be turned over to the Entertainment Committee, which shall neither ask nor accept any further contribution from any member of the Water Works Manufacturers' Association. It may, however, solicit contributions from Associates of the New England Water Works Association who are not members of the Manufacturers' Association, and from other individuals not connected with the latter Association. The administration of this entertainment fund shall be in the hands of the Entertainment Committee, which shall return to the contributors, pro rata, any funds remaining after the Convention bills have been paid, and shall render a report of its doings, receipts, and expenditures, to the Executive Committee of the New England Water Works Association.

4. The right of Associates of the New England Water Works Association to have a representative at all meetings of the Association, as permitted by the Constitution, is hereby determined to be limited to a single representative in the case of the Annual Convention, and such representative may introduce a single guest. Associates desiring to be represented by additional representatives

at the Convention may do so on the payment of $5 for each additional representative, each such payment to carry the privilege of introducing one guest. All moneys received from such payments for additional representatives shall be turned over to the Committee on Exhibits and used in defraying the necessary expenses of that committee.

After discussion, on motion of Mr. Bancroft, seconded by Mr. Brooks, it was *voted*, that the recommendations be adopted for the convention of the Association of the year 1915.

The President is by vote made a member of the Committee of Arrangements, with power to appoint proxy.

Adjourned.

Attest:

WILLARD KENT, *Secretary*.

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New England Water Works Association.

ORGANIZED 1882.

Vol. XXIX. September, 1915. No. 3.

RAINFALL IN NEW ENGLAND.*

BY X. H. GOODNOUGH, CHIEF ENGINEER, MASSACHUSETTS STATE BOARD OF HEALTH.

[*Read December 10, 1913.*]

With the rapid development in the use of lakes and rivers for water supply, irrigation, and industrial purposes, observations of the flow of streams and of the relation of rainfall to stream flow have become of great practical value. The number of places at which observations of both the rainfall and stream flow have been continuous for long periods of years is quite limited, the most notable in New England being the records of the observations on the Sudbury River, begun in 1875. These records have been used very generally as a basis for estimating the probable flow of streams and yield of watersheds in other parts of New England and even beyond its borders.

Observations of the rainfall, on the other hand, have been made at a far greater number of stations and cover much longer periods of years than the records of stream flow, and when used in connection with the known relation between rainfall and run-off in the watersheds of a few carefully measured streams furnish the best practicable basis for estimating the probable flow of other streams and the yield of watersheds, for which no data other than rainfall are available.

* In the preparation of this paper the writer has had the assistance of Mr. R. M. Whittet, Assistant Engineer, State Board of Health, in the collection of much of the data and information relating thereto, and of Mr. H. R. Crohurst, also of the Engineering Department of the Board, who has made many of the studies and diagrams.

A study of the variations that have occurred in the amount and distribution of the annual rainfall is of particular interest at the present time. The past few years, especially the period from 1908 to 1911, have been characterized by a remarkable deficiency in precipitation in New England, and the flow of the carefully measured rivers has fallen in many cases to the lowest level thus far recorded. This deficiency has been ascribed to various causes, — among others, to periodic variations in accordance with natural laws, to a gradual reduction in the amount of the rainfall, to changes in its seasonal distribution, and to a reduction caused by destruction of the forests, — and it has appeared worth while to collect, so far as possible, all the observations of the rainfall that have thus far been recorded in New England, in order to obtain from them such information as they may supply relative to the amount and distribution of the rainfall and the variations that have occurred in the past. For the purpose of this study much time has been given to making as complete a collection as possible of the rainfall observations that have thus far been made in New England since the earliest times, including observations at stations in adjacent portions of the adjoining states and provinces.

The greater part of the rainfall records available for New England have been published at various times in the reports and bulletins of the Weather Bureau of the United States Department of Agriculture. Others are to be found in the publications of the New England Meteorological Society, in the reports of water departments of cities and towns, and in the annals of academies and colleges. Several important records have been found in other publications, and a few have been obtained from original manuscripts which have not hitherto been made public.

The earliest observations of rainfall in New England that have thus far come to light are those made by Professor Winthrop at Cambridge, Mass., which were begun in a period of excessive drought in August, 1749. These observations are continuous until the day of the Battle of Lexington, in 1775, and summaries of the results have already been published, though not in full. The average rainfall during these twenty-five years as recorded by Professor Winthrop is somewhat smaller than in similar periods of recent years, and since no record has been found describing the

instruments used and the methods followed by the observer, his observations have hitherto apparently been given little attention by those interested in this subject.

Next to Benjamin Franklin, Professor Winthrop was the most prominent scientific man of his century in America, and it is hardly to be doubted that his records were made with care and accuracy. Before beginning his observations, Professor Winthrop evidently caused his instruments to be carefully prepared for the purpose, as is indicated by the following extract from the records of the Corporation of Harvard College.

. . . . "15. That one & thirty shillings, Eight pence & 4/5, be allow'd to the Professr of Nat. Phil & Methem. in full Discharge of his Acco of July 1749. being an Acco of Vessells prepar'd for Measuring the Quantity of Rain."

An examination of Professor Winthrop's diary* shows that his general notes and observations of weather conditions coincide with his meteorological records, and other contemporary chroniclers confirm his observations. That the difficulties of securing accurate measurements of the precipitation, especially in winter, were well recognized in Winthrop's time is quite clearly shown by the notes of the Rev. Manasseh Cutler, whose meteorological records will later be referred to, and there appears to be no reason whatever to doubt the accuracy of Professor Winthrop's records.

After leaving Cambridge, in 1775, Professor Winthrop continued his observations for a time at Concord and afterward at Watertown, and later returned to Cambridge, but the records for some of the months are missing and the observations were discontinued in 1779.

No records have been found showing actual measurements of the rainfall for the years 1780 and 1781, but in the latter year meteorological observations were begun at Ipswich by Rev. Manasseh Cutler, who began later — September, 1782 — to measure and record the amount of precipitation in the form of rain and snow. This observer gives a description of his rain gage and the method followed by him in making his observations. This statement, which is quoted below, is of great interest in that it shows that the

* Library of American Academy of Arts and Sciences, Boston.

observer appreciated fully the difficulty of securing accurate observations, especially in the winter season.

. . . "The quantity of rain is measured by an ombrometer, made of tin, twelve inches square at the mouth, the sides of which are perpendicular. The rain falls through the mouth into a funnel, which conducts it into a reservoir, where it is secured from evaporation; and is, afterwards, decanted off and measured in a three-inch cubic measure. It stands firmly secured, in an open situation, with the mouth about two feet from the ground. The quantity of water contained in snows, is generally ascertained by taking the cubic measure of a column of snow, at its mean depth, from the surface to the bottom, and dissolving it in the ombrometer. But as snows frequently fall one upon another, or are accompanied with rain, there is great difficulty in ascertaining, with exactness, the quantity of water that falls during the winter. . . ."

It seems reasonable to assume that Professor Winthrop's records were kept with at least equal care and that his observations are as nearly accurate as those of more recent times. The results of Mr. Cutler's observations will be found in the "Memoirs of the American Academy," Vol. 1. Unfortunately, Mr. Cutler's observations were continued only from September, 1782, to the end of the year 1783.

A more extended record of the rainfall of this period was evidently made by Rev. Jonathan French, at Andover, whose diary appears to be still extant, though it has thus far been impracticable to obtain access to it even for the purpose of securing the records of rainfall and other meteorological observations it contains. Fortunately, portions of these observations are to be found in Abbot's "History of Andover," published in 1829, which contains French's records of rainfall complete for the years 1782 to 1786 inclusive, and also for the years 1793, 1798, 1800, and 1803. These observations show very high rainfalls in the years 1783, 1784, and 1785, especially in the latter year, when the aggregate rainfall for the months of September and October amounted to 19.3 in. It is interesting to note that one of the greatest, and possibly the greatest, freshet ever known in the Merrimack River valley occurred in October, 1785.

Another observer who appears to have measured the rainfall

carefully at about this period was Prof. Samuel Williams, LL.D., a member of the Meteorological Society in Germany, of the Philosophical Society in Philadelphia, and of the Academy of Arts and Sciences in Massachusetts. He was the Hollis Professor of Mathematics at Harvard and the successor of Professor Winslow. In his "Natural and Civil History of Vermont," written in later years, he presents a table of five years' observations of the rainfall at Cambridge, 1784–88, presumably kept by him, but as the record simply presents an average for these five years and the details have not come to light, the observations are of little practical value. He does present, however, a record of the rainfall at Rutland, Vt., for the year 1789, which happens to be the only rainfall observation in New England for that year that has thus far been found. For the years 1790 and 1791 no observations have thus far been found.

Two observers began the measurement of rainfall in 1792; one, the Rev. Jonathan Newell, A.M., who lived at Stow, Mass., and the other, Joseph Barrell, Esq., whose observations were made at Charlestown, Mass. The records at Stow are continuous from 1792 to 1804 inclusive, and those at Charlestown from 1792 to 1802. The description of the rain gage used by Barrell indicates that it was situated on land about 60 ft. above the level of high tide and was located in an open situation where it could not be affected by rain falling from structures or trees, so that an effort appears to have been made to secure a satisfactory location.

Comparing the two observations, the records at Stow are considerably higher than at Charlestown. The principal differences in the rainfall recorded at Stow, Charlestown, and Andover in the years when comparisons can be made, are found in the summer season, principally in the months from June to September, and are no greater than are found in comparing observations at widely separated stations for those months in later years.

The next important record is found in the observations at New Haven begun in 1804 and carried on continuously until 1821, and subsequently intermittently until 1873. Since 1873 they have been continuous up to the present time. Other than the records found at New Haven, no observations are available for the years 1805 to 1807 inclusive.

Observations were begun at Brunswick, Me., in 1808 and continued to 1818, though some of the months are lacking. Most of the years, however, are complete.

The longest continuous record of rainfall in New England that has thus far come to light is that which was kept at New Bedford by Samuel Rodman and his son, from 1814 until 1905, thus giving, with the use of records of other New Bedford observers, a continuous record of rainfall at one place for one hundred years. The observations were evidently made with great care, and the record is believed to be a thoroughly reliable one. It furnishes the best information anywhere available in New England as to the variations that have occurred in the rainfall at the same place in a period of one hundred years.

Next to New Bedford, the longest continuous record of rainfall observations available in New Engand is that kept at Boston, at first by Dr. Enoch Hale, 1818–22; then by Jonathan P. Hall, 1823–65, and in later years by several other observers. Among the latter are the United States Weather Bureau, which has for many years maintained a meteorological station on top of the Post-Office Building, and the Boston sewer and water departments. The observations of the Weather Bureau in the very wet years that occurred in the late '80's were surprisingly low as compared with others in and about the city, and these observations have been regarded as unreliable. There is also much doubt as to the reliability of the observations recorded in the period between 1856 and 1878 inclusive. In these years the rainfall at Boston greatly exceeded that of any of the other stations in the region about it where reliable records were kept during that period.

After Boston the longest continuous record is that maintained at Waltham by the Boston Manufacturing Company, begun in 1825. The records of several of the months in the earlier years are lacking, but these earlier records can be made available without danger of serious error by supplying figures for the missing months from other stations in eastern Massachusetts.

The next record of importance is that begun at Lowell by the Merrimack Manufacturing Company in 1826, and maintained continuously to the present time. The observations of the Proprietors of Locks and Canals, controlling the water power on the

Merrimack River, were begun in 1855 and have also been continuous since that time, so that it is practicable to secure a record at Lowell covering a period of eighty-eight years.

Next to Lowell, the longest continuous record available is that at Providence, R. I., beginning in 1832.

After 1832, the number of continuous rainfall records increases quite rapidly. That at Amherst, Mass., was begun in 1836; at Gardiner, Me., in 1837; at Burlington, Vt., in 1838; at Worcester, Mass., 1841; and at Cambridge, Mass., 1841. Doubts have been expressed as to the reliability of the latter record previous to 1867.

Observations of the rainfall were made at Lynnfield by General Newhall, beginning in 1842 and ending in 1878, the results of which have not apparently hitherto been published. The records of these observations have been carefully examined, and it appears that, excepting for a few months when the observer was ill and when observations were made by another person, the measurements were evidently made by General Newhall, and his notes of the weather and other conditions correspond with the rainfall observations. In these records the occurrence of light rains is frequently noted without a record of the quantity, indicating the occurrence of a fine rain or small shower in which the amount of precipitation collected was very small and was regarded as insignificant.

Two other observation stations were established previous to 1850, one of which — that at Springfield, Mass. — has been maintained to the present time, while the other — that at Lunenburg, Vt. — was closed in 1891.

After 1850 additional stations for the observation of the rainfall, many of which have since been maintained continuously, were established in gradually increasing numbers, and in the earlier '70's about fifty such stations had been established either in New England or very close to its borders at which observations have been continued to the present time without interruption.

It has also been possible to obtain several long records of observations at places outside of New England, chief among these being the observations at Albany, N. Y., where records are continuous since the year 1826, and at New York City, where, by combining the records kept at Fort Columbus, the Deaf and Dumb

Asylum, and at Central Park, a continuous record is obtainable from 1836 to the present time. A long record is also found at Troy, and other important records of less length have been found on the Croton watershed and elsewhere.

At St. John, N. B., near the easterly border of Maine, continuous rainfall observations have been maintained since 1861.

Rainfall Records and Methods of Observation.

It is impracticable to consider here in detail the questions relating to the methods of observation and the accuracy of the results at all of the various stations where measurements of the rainfall have been made in New England. The earlier observers of meteorological phenomena probably lacked the refinement of modern methods of observation, and some of these earlier records have for these reasons been regarded as unreliable. In many cases the instruments used and the methods followed are fully described by the observer, and it is practicable from that information to form a judgment as to the probable reliability of the observations recorded. Many of the longer records have been examined carefully by engineers and others interested in the subject, and their conclusions relative to the reliability of the records have in some cases been published. In a few cases the description of the rain gage or the circumstances affecting its location have left an uncertainty as to the reliability of the records, but there is little reason to doubt that in general the more important of the older records were kept with as much care and are as reliable as those of more recent observers.

It is usually practicable, especially in the case of very wet or very dry seasons, to obtain evidence from newspapers, diaries, or other contemporary records which will aid considerably in forming an estimate of the probable reliability of a given set of observations, and a check upon winter precipitation records can often be obtained from such chroniclers, some of whom are quite careful in recording the depth of snow.

In an examination of the journals of the earlier observers it will sometimes be found that they note the occurrence of rain or rainy weather without any corresponding record of or reference to the amount of precipitation, but such occurrences do not neces-

sarily throw doubt upon their observations. The very small quantities of rain or snow, five one-hundredths of an inch or less, recorded by modern observers were apparently in some cases not considered worthy of note in earlier times, but neglect to record such small amounts does not probably affect materially the value of the observations. An examination of the results of careful observations at a number of stations in several recent years, made to determine what percentage of rainfall occurs in amounts of five one-hundredths of an inch or less, indicates that in wet years probably about 2 per cent. and in dry years probably about $1\frac{1}{2}$ per cent. of the total rainfall occurs in these small amounts.

Doubt has been expressed as to the reliability of many of the older records, especially those of the period from 1830 to 1850, on account of the small amount of precipitation generally recorded in the winter season in that period, this fact being held to indicate that the amount of precipitation in the form of snow had not been accurately measured. Comparisons of the winter precipitation in the drier period in the 30's and '40's with the winter precipitation at the same stations for earlier or later years fail to show that these suspicions are justified except possibly in a very few cases. Even the earliest observers evidently knew very well the difficulty of securing reliable observations in winter, and it is probable that in most cases their observations were carefully and accurately made.

The measurements of the quantity of rainfall recorded by the earlier observers were no doubt usually made by measuring the depth of water collected with a graduated rule. Observations of careful measurements of depths of rainfall in rain gages of the size ordinarily used indicate that such results differ little from those obtained by the more exact method of weighing, including allowance for temperature, and errors due to differences in method of measurement commonly balance one another.

With some of the smaller gages having an internal measuring tube of one inch diameter or less, the use of a measuring stick may, on account of its displacement, increase materially the apparent depth of water collected. Observations with one such gage that has long been in use indicate an error from this cause of between 6 and 7 per cent.

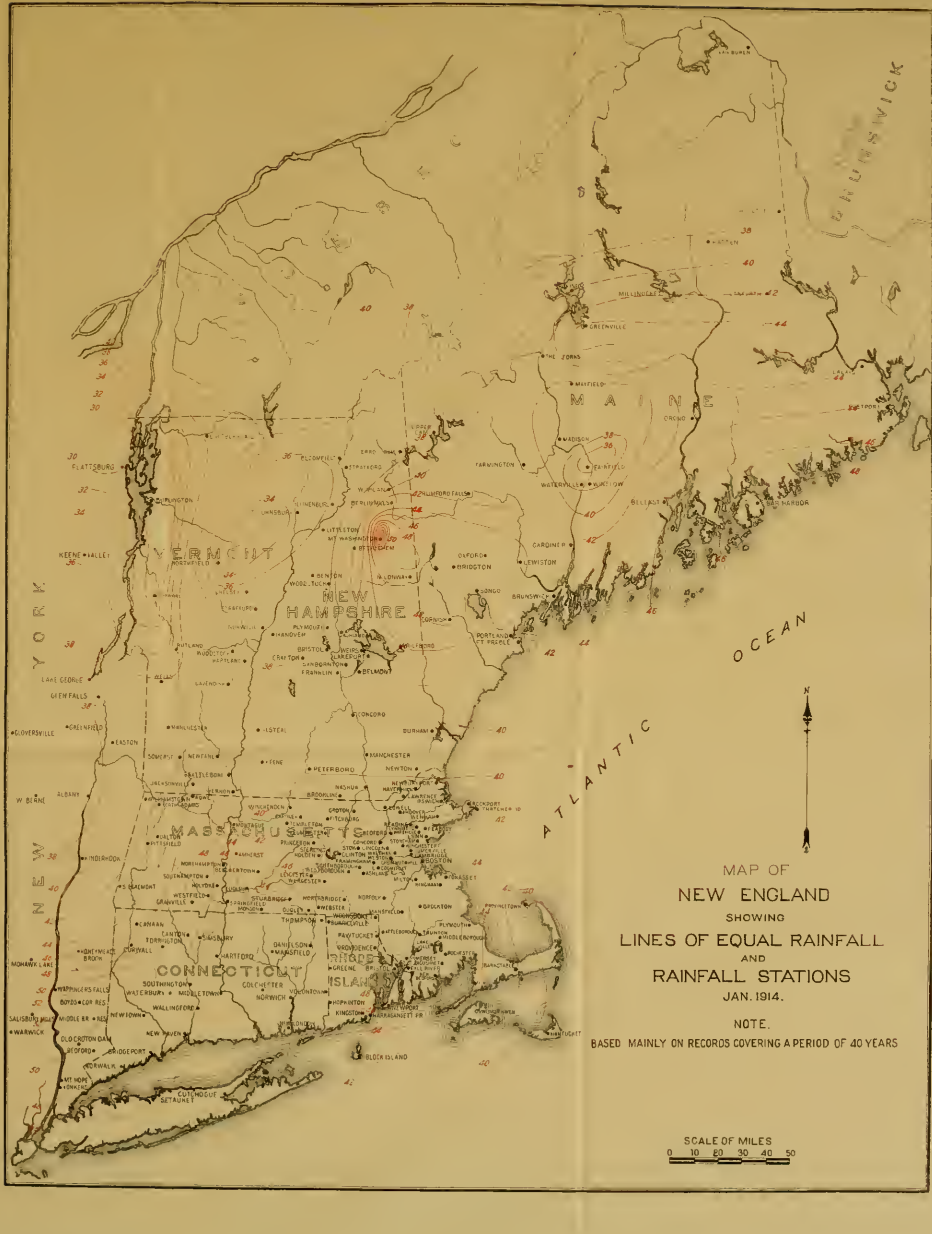
In the course of these investigations it has been practicable to examine but a small proportion of all the rain gages in use in New England. In a number of cases the conditions found were such as to impair the value of the records, and these faulty observations have been included in official publications. The inaccuracies result from various causes, including, beside inaccurate methods of measurement, faulty types of gage, poor location, and lack of proper care in recording observations. It is quite difficult to locate a rain gage so as to secure reliable results, especially in populous neighborhoods, and it is also difficult to secure accurate observations of the depth of snow, but the amount of precipitation in the form of snow is not large in comparison with the total annual precipitation, especially in the southern and eastern portions of the district, and the ordinary standard gages in a fair exposure probably give reasonably accurate results.

The results of the examination of many rain gages show clearly the necessity of efficient inspection of the location and condition of the gages in use, the methods of observation, etc., if reliable results are to be secured.

Geographical Distribution of the Annual Rainfall.

To the casual observer there is little apparent difference in the amount of the annual rainfall in different sections of New England. In the northern and western parts of the district, the precipitation in winter is generally in the form of snow, which often accumulates by the end of the winter to a depth of 4 or 5 ft. In the southern and eastern districts, especially near the coast, the winter precipitation is more usually in the form of rain, though these districts also are sometimes covered deeply with snow. Aside from the differences in the form of precipitation in winter, there is very little apparent difference in the distribution of the annual precipitation throughout the district. But an examination of the results of recorded observations, especially when considerable periods of years are taken into account, shows that there are marked variations in the annual total, which must have a material influence upon the comparative flow of streams and yield of watersheds.

PLATE XXII.
N. E. W. W. ASSOCIATION,
VOL. XXIX.
GOODNOUGH ON
RAINFALL.



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A satisfactory determination of the amount of the annual rainfall for all parts of New England is impracticable with the data at hand. The longer records cover a sufficient number of years to give reasonably reliable results, but the number of such records is too limited to represent the rainfall in all parts of the district satisfactorily. Observations for the past forty years are available at as many as thirty-six stations, but, of these, twenty-five are located in the three southern states, while two are found in Vermont, four in New Hampshire, and only five in the large area of Maine. There are also a few available records for this period in adjacent states and provinces, but when all are plotted on a map there are wide spaces, especially in the western and northern sections of the district, for which no observations for long periods are available. Nevertheless, these records furnish much interesting information as to the geographical distribution of the rainfall, and, by supplementing them with observations for shorter periods in areas where records for the longer periods are lacking, it is practicable to indicate quite definitely the approximate annual rainfall throughout the greater part of New England.

In using observations for short periods it is necessary to take into account the fact that the amount of the annual rainfall varies greatly from time to time and an average of the rainfall for a shorter period may not represent accurately the average rainfall for a period as long as forty years, but the conditions which govern the amount of rainfall in New England in a given group of years apparently affect the district as a whole, and a period of high or low rainfall, as the case may be, at a few stations is usually a period of high or low rainfall at most of the stations at which observations have been made. Under the circumstances, in cases where it has been found desirable to use short records or records for other periods than the past forty years, the probable corresponding amount of rainfall for the latter period has been estimated by proportion, using the longer records in the same region as a guide. The results have been plotted on a map of New England, upon which lines have been drawn through stations having an equal annual rainfall, and in those areas in which the number of available observations is inadequate to furnish a reliable guide, the probable rainfall is indicated by broken lines. (Plate XXII.)

An inspection of the map shows at once that there are marked variations in the amount of the annual rainfall in different parts of this comparatively small district. The highest rainfall recorded at any place in New England is at the summit of Mt. Washington, where observations were made continuously from September, 1871, to 1887. The average rainfall during that period was 83.53 in. The lowest rainfall recorded in New England is that along the shores of Lake Champlain, where at Burlington, Vt., the average rainfall for a very long period of years has amounted to 32.76 in.

Probably the most striking feature brought out by this map is the high rainfall in the mountainous districts, especially along their easterly slopes. In the Green Mountains in Massachusetts and Connecticut, in the hills of central Massachusetts, in the White Mountains of New Hampshire, and in the highlands of western Maine, the rainfall is generally much higher than in adjacent regions. The number of stations in the Green Mountains of Vermont is too limited to show clearly whether or not this rule holds in that region, but such is very probably the case, and the lines on the map have been plotted in such a way as to indicate the probability of a higher rainfall along the central and easterly portions of these mountains. In the hilly portions of central Massachusetts there are very few records covering long periods, but there are enough to indicate pretty clearly the probable differences between the annual rainfall of this region and that of the valleys to the east and west.

It is evident from a consideration of the available records that the effect of elevation upon the rainfall is very marked, and it is probable that the higher rainfall in the mountainous districts has not hitherto always been adequately considered in studies of the flow of streams and yield of watersheds. Unfortunately, except at the summit of Mt. Washington, few rainfall stations have been maintained among the higher ranges either in the White Mountain region or the other mountainous regions of New England, so that it is impossible to ascertain definitely the extent of these areas of high rainfall. In the White Mountain region the very high rainfalls are very probably confined to the highest summits and diminish rapidly as lower levels are reached, though the records available show very clearly that the rainfall

south and east of these mountains is higher than elsewhere in this region except on Mt. Washington. There are indications also that the rainfall in western Maine along the easterly slope of the extensive highlands west of the Kennebec River is higher than in the central and northern portions of the state.

The rainfall at Bar Harbor at the eastern base of the mountains of Mt. Desert is much higher than elsewhere in this region, and it is possible that along the highlands toward the north of Bar Harbor and east of Bangor similar conditions obtain, but the available records are inadequate to show except in a very general way the variations in rainfall in that region.

Aside from the higher rainfall of the mountainous districts, the highest precipitation in any large area in New England occurs in the southern portion of the district. This area of high rainfall extends from the neighborhood of the Croton watershed in New York, where the rainfall is higher than in adjacent portions of New England, across Connecticut, Rhode Island, and parts of southeastern Massachusetts, nearly to the eastern coast of the latter state, the amount gradually diminishing as a rule from approximately 50 in. in western Connecticut to about 46 in. in southeastern Massachusetts.

South and east of this area the rainfall diminishes to about 44 in. toward the easterly end of Long Island Sound, and to about 45 in. at Block Island and 39 in. at Nantucket. Toward the north, also excepting along the easterly slopes of the Green Mountains of western Connecticut and Massachusetts, and in the hilly region about Mt. Wachusett, the rainfall diminishes rapidly, falling in northwestern Massachusetts toward an area of low rainfall in the Hudson valley in the neighborhood of Albany and Troy.

Following the northern boundary of Massachusetts between the Connecticut and Merrimack rivers, the annual rainfall amounts to from 40 to 42 in., while farther north the amount in general gradually diminishes except in the higher lands, the average rainfall over a wide area in the Connecticut Valley in eastern Vermont amounting to about 34 in. Farther northwest in the basin of Lake Champlain the precipitation is the lowest that has been observed anywhere in New England, the average at Burlington, Vt., for a period of forty years amounting to only

31.6 in., while across the lake at Plattsburg, N. Y., the average amount falls to less than 30 in. In northeastern Massachusetts, also, including the lower Merrimack valley and adjacent watersheds draining toward the coast, the rainfall diminishes considerably from the amounts recorded in the hilly country of the central part of the state, the decrease occurring chiefly in the winter and spring. In this section of Massachusetts and adjacent portions of the coast sections of New Hampshire and Maine the amount of rainfall ranges from 41 to 42 in. North of the White Mountains the amount diminishes rapidly in the lower lands toward the valley of the St. Lawrence River.

In Maine there is apparently an area of low rainfall in the northern part of the Kennebec River valley, where the amount falls to an average of 36 in. per year. The rainfall at Bar Harbor, as already noted, is much higher than elsewhere in this region, amounting to about 48 in. per year. Farther east the amount increases, and at Halifax, N. S., it averages 57 in. per year, a much higher quantity than is found anywhere in New England, except in the highest mountain districts.

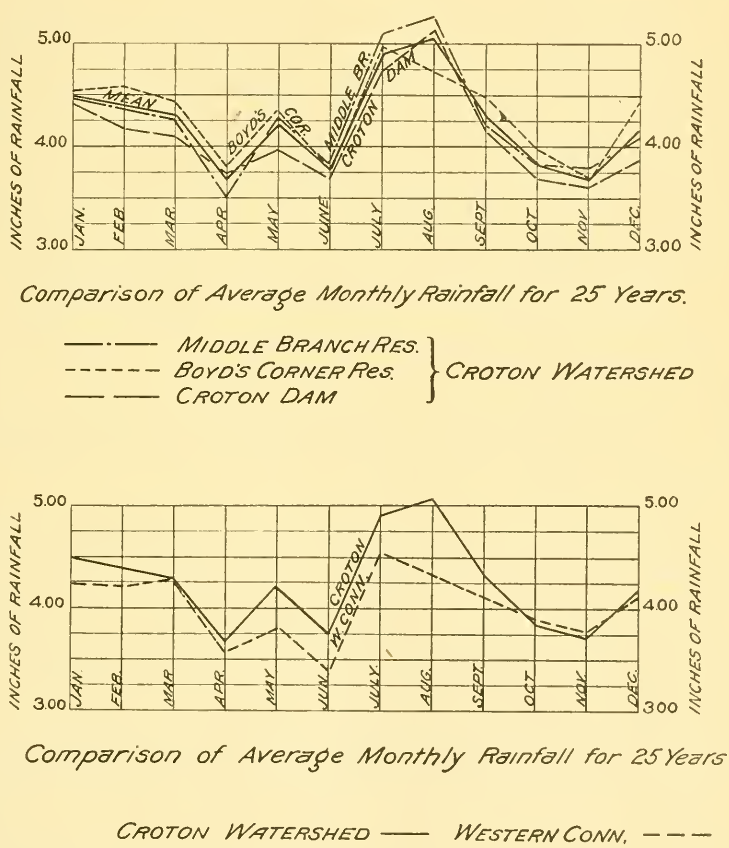
The results of this study show that there are very decided differences in the geographical distribution of the annual rainfall in various sections of New England which are of great importance in making comparisons of the flow of streams and the yield of watersheds in different parts of this district, since an annual rainfall of 45 in. or more, which occurs in large and widely separated areas, would produce a higher run-off in the streams — other things being equal — than an average annual precipitation of less than 38 in. recorded in many other large sections of the district. The effect of these differences upon the flow of streams is dependent to a large extent, however, upon the seasonal distribution of the rainfall, which will next be considered.

Seasonal Distribution of the Rainfall.

A further analysis of the records of rainfall discloses important variations in the distribution of the monthly and seasonal precipitation which are most readily compared when the average monthly precipitation at different stations in different localities is plotted

in the form of a diagram. A comparison of the average rainfall for each month at stations in the same general neighborhood having a similar annual rainfall usually shows that the differences in seasonal distribution are slight and that there is a close correspondence in the variations from month to month.

DIAGRAM NO. 1



Comparison of Average Monthly Rainfall for 25 Years.

Comparison of Average Monthly Rainfall for 25 Years

For example, records are available for periods of twenty-five years or more at three stations on the Croton watershed, viz., the Old Croton Dam, Boyd's Corner Reservoir, and the Middle Branch Reservoir, and the average monthly rainfall at each of these stations for the twenty-five years which ended with 1910 has been computed and is shown graphically in the upper part of diagram No. 1. An inspection of this diagram shows that the rainfall from month to month at each of these stations exhibits the same general characteristics, and that the differences in amounts recorded at the various stations in each month are not excessive. An average of the observations at the three stations for the twenty-five years in question is also shown on the diagram and probably gives a fair indication of the usual monthly distribution of the rainfall in the region of the Croton watershed. In a similar way the rainfall at six stations in western Connecticut for the same period has been compared, and here also it is probable that an average of the observations gives a fair indication of the usual monthly distribution of the rainfall in that section of New England. A comparison of the monthly rainfall in this district with that on the Croton watershed is shown in the lower part of diagram No. 1.

This comparison shows that the rainfall in the two districts is distributed through the year in much the same way. The total precipitation is smaller in western Connecticut, due chiefly to a lower rainfall for the months from September to May inclusive, though the rainfall in the winter months is also less than on the Croton watershed.

A notable feature of the distribution of the rainfall in these districts is the high precipitation in summer, the amounts recorded in July and August being much greater than in any of the other months in the year. The lowest precipitation occurs in the spring, in the months of April and June, and another period of low precipitation in the autumn, in October and November.

It is also practicable to compare the rainfall at the Old Croton Dam and the Boyd's Corner stations on the Croton watershed for a period of thirty-eight years, ending in 1910, with the rainfall at five stations in western Connecticut for the same period. The results on the whole are quite similar to those of the twenty-five year period, but in the longer period the rainfall on the Croton

watershed was higher in every month than at the stations in western Connecticut.

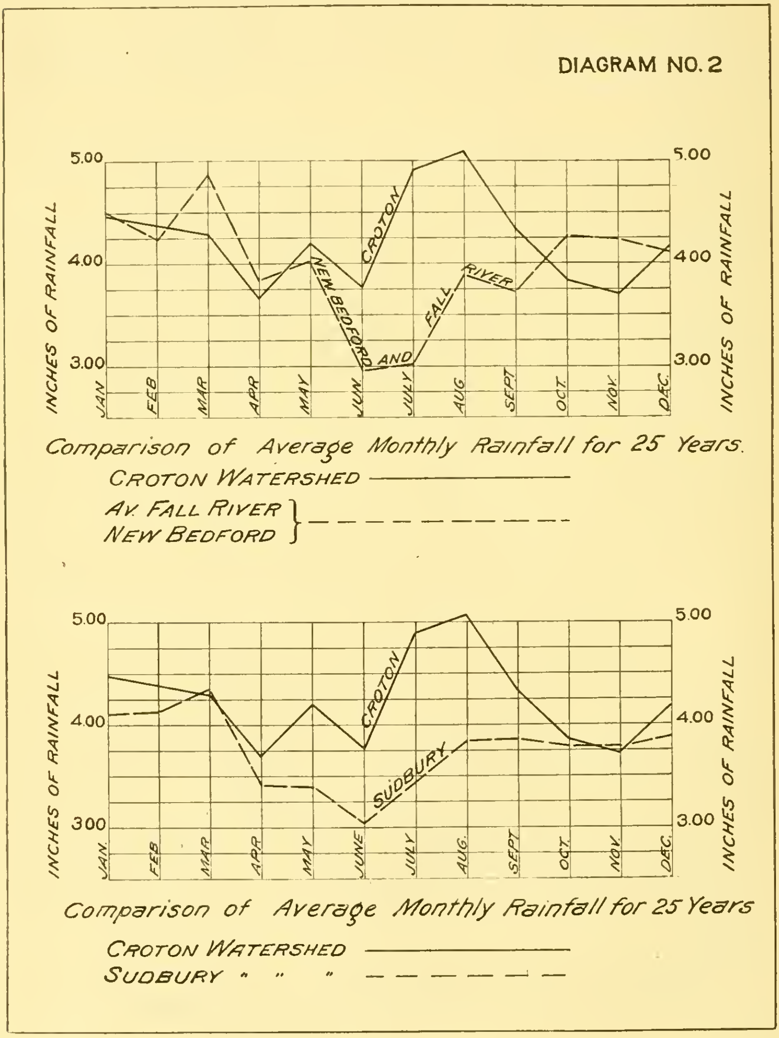
Following this method, the average monthly rainfall for a large number of districts throughout New England has been compared with very interesting results, some of the more notable of which will be presented here.

It has already been shown that an area of high rainfall extends from the neighborhood of the Croton watershed across southern New England, diminishing but little until it approaches the eastern coast.

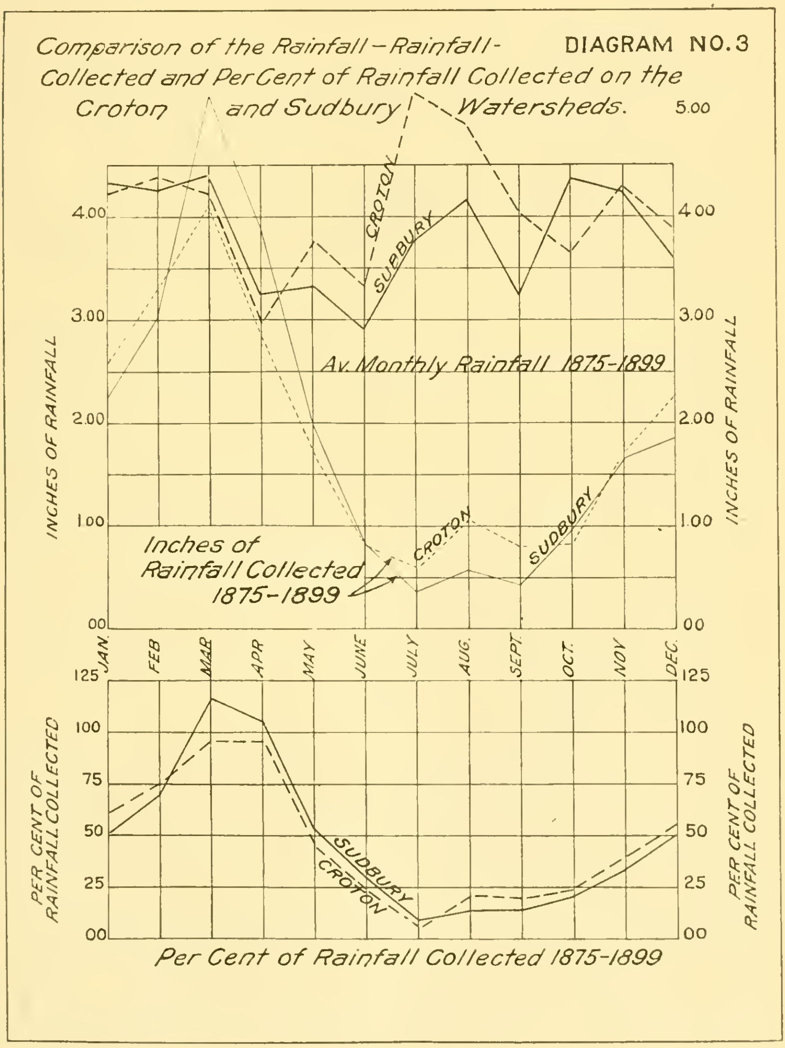
The average rainfall on the Croton watershed amounted in the twenty-five years from 1886 to 1910 to 50.8 in., while the average rainfall at Fall River and New Bedford, near the eastern extremity of this area of high rainfall, was for the same period 47.6 in. A comparison of the monthly rainfall in these two districts is shown on the upper part of diagram No. 2. An inspection of this diagram shows a remarkable difference in the distribution of the rainfall in these two districts. On the Croton watershed the maximum occurs in the summer months of July and August, and the minimum in April and November, while at Fall River and New Bedford the maximum occurs in March and the minimum in the summer months of June and July. The average rainfall at Fall River and New Bedford is considerably higher than on the Croton watershed in the months from October to April inclusive, and as this period includes the portions of the year when the percentage of rainfall collected in the streams is greatest, it is probable that during these months the average yield of the streams in southeastern Massachusetts would be somewhat higher than on the Croton. On the other hand, from May to September the average rainfall on the Croton is very much higher than at Fall River and New Bedford, but as the percentage of rainfall collected in these months is comparatively small, it is not probable that the higher annual rainfall on the Croton watershed produces a materially higher flow in the streams in that region than results from the somewhat smaller annual rainfall in southeastern Massachusetts.

A comparison of the average rainfall at the three stations on the Croton watershed for the twenty-five years already indicated

with the monthly rainfall in the same period — 1886–1910 — on the Sudbury River is shown in the lower part of Diagram 2. This comparison is a very interesting one. The rainfall on the Sudbury watershed during the months from October to March, inclusive, during this period averaged about the same as on the Croton,



while throughout the late spring and the summer months, from May to September, inclusive, the rainfall on the Croton watershed was much higher than on the Sudbury. For the entire period the rainfall on the Croton watershed was 50.8 inches, and on the Sudbury, 45.90 inches.

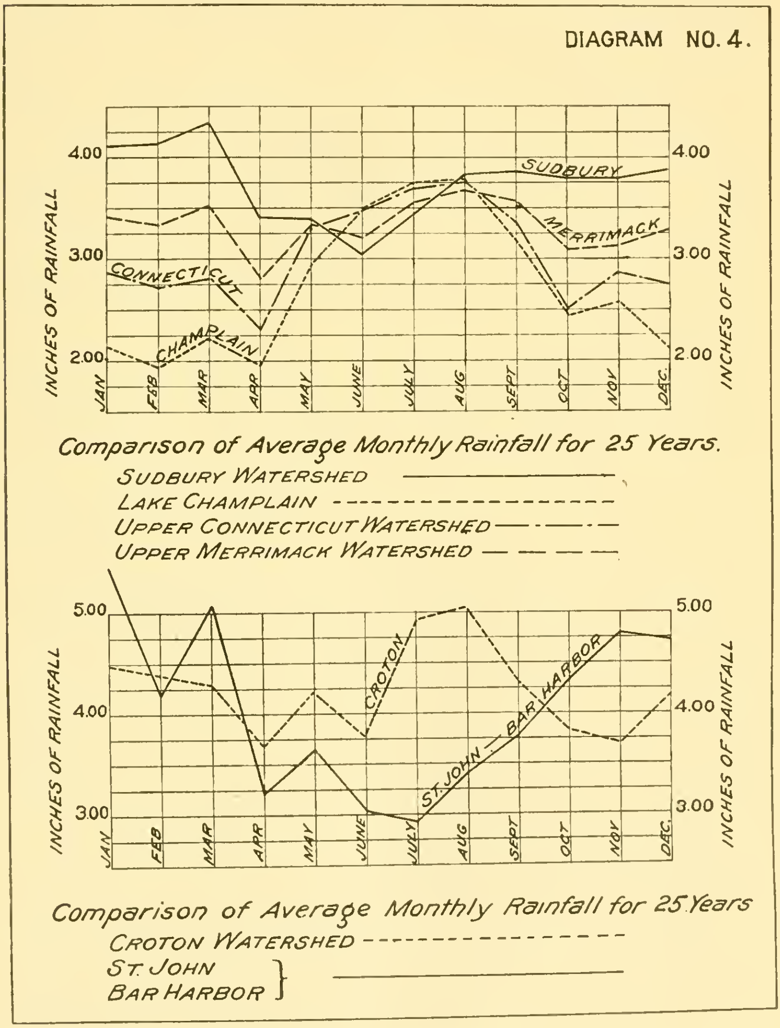


It so happens that it is practicable to compare both the rainfall and stream flow on the Croton and Sudbury watersheds respectively for a period of twenty-five years from 1875 to 1899, and this comparison is shown in the upper part of diagram No. 3. It will be seen from this diagram that, while the rainfall in this period differed considerably on both the Sudbury and Croton watersheds from the amount recorded in the twenty-five years from 1886 to 1910, the relative amounts of rainfall on each watershed in these two periods were approximately the same, the average rainfall on the Croton watershed from 1875 to 1899 being 48.77 inches per year, and on the Sudbury 45.83 inches. The rainfall on the Sudbury was higher than on the Croton in this period in the months of October, January, March, and April; in all other months it was lower, especially the months from May to September, inclusive.

Taking the period as a whole, in contrast to this marked difference in the amount of the rainfall, the average stream flow in these two watersheds was almost exactly the same, amounting in this period to 22.50 inches per year on the Croton and 22.48 inches on the Sudbury. The actual amount of rainfall collected on the Sudbury watershed exceeded that on the Croton only in the months of March, April, May, and October; yet the excess in these months, especially in March and April, counteracted wholly the effect of the higher average rainfall on the Croton watershed, which is due largely to a marked excess in the summer months, when the yield of watersheds is least. The actual percentage of rainfall collected on each watershed by months is shown in the lower part of diagram No. 3.

In the next diagram, No. 4 (upper portion), is shown a comparison of the monthly rainfall on the Sudbury River watershed with the rainfall of three large districts in northern New England, viz., the upper Merrimack River valley, the upper Connecticut River valley, and the region of Lake Champlain in the period 1886–1910. This comparison shows that the maximum rainfall during this period in all of these northern districts occurred in the month of August and the minimum in the month of April, while on the Sudbury the maximum occurred in March and the minimum in June. The rainfall in all of these districts for the

months of July and August was much the same, while in June and July the rainfall on the Sudbury was less than that in the other valleys. In all other months of the year excepting May the rainfall on the Sudbury River is much the highest. It will be noted that



the amount of rainfall in the districts compared decreases regularly toward the north and northwest.

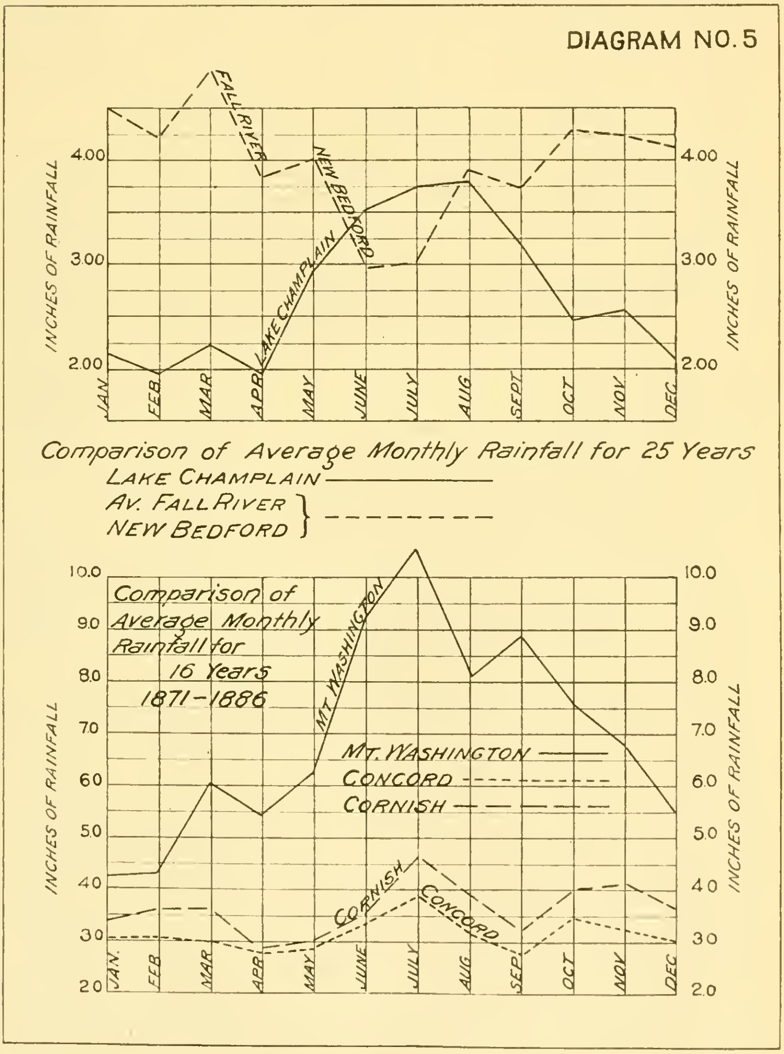
It is evident from this diagram that during the months from May or June to August or September, inclusive, — that is, during the period of the growing of crops, — there are no great differences in the monthly rainfall throughout the principal valleys of central and northern New England, so that, so far as agricultural operations are concerned, neither section has any natural advantage over the other in respect of the amount or distribution of the rainfall; but during the autumn months — and especially in the winter and spring, when the percentage of the rainfall reaching the streams is highest — the rainfall on the Sudbury watershed is much greater than in the northern valleys, and this difference is so great that it is essential that it be taken into account in considering the yield of watersheds in these districts, especially where storage enters into the calculation.

In the lower portion of diagram No. 4 is shown a comparison of the monthly rainfall on the Croton watershed with the rainfall at Bar Harbor and St. John for the same period of twenty-five years ending with 1910. The results of this comparison are similar to those already made between the rainfall on inland areas and those near the coast. On the Croton watershed the maximum rainfall occurs in summer and the minimum in the spring and autumn, while at Bar Harbor and St. John the minimum occurs in summer and the maximum in winter. The average annual rainfall on the Croton watershed during this period was 50.8 in., and at Bar Harbor and St. John 48.6 in., but since the percentage of rainfall collected in the streams is very much greater in the winter and spring than in the summer, it is probable that a considerably larger yield on a given area would result from a rainfall distributed as at Bar Harbor and St. John than from an equal amount of rainfall distributed as on the Croton watershed.

In the upper portion of diagram No. 5 is shown a comparison of the rainfall at Fall River and New Bedford, the extreme southeastern part of the district, with the rainfall in the region of Lake Champlain, in the extreme northwestern section. The results are much the same as those shown by previous diagrams, the rainfall at Fall River and New Bedford being somewhat less in summer

than in the region about Lake Champlain, while in several of the winter and spring months the rainfall in the southeastern district is nearly twice as great as in the Champlain region.

The most interesting in many ways of all the diagrams com-



paring the seasonal distribution of the rainfall in New England is the comparison of the monthly rainfall for the years 1871–1886 on the summit of Mt. Washington with that of the two nearest stations to the southwest and southeast at which records are available for the same period. This comparison is shown in the lower portion of diagram No. 5. It will be noted that the rainfall on Mt. Washington is not extraordinarily greater than that at Cornish in the months of January and February, but that the differences in all the other months are very great, especially in the summer.

An interesting fact brought out by these diagrams is that the maximum rainfall in the central and northern districts of New England occurs in summer, while in the coast districts the maximum practically always occurs in the winter and spring. A further study of this difference has been made by indicating upon a map of New England the month of maximum rainfall at each station during the last twenty-five years. The result shows that along the eastern coast and for several miles inland, the maximum monthly rainfall during these years has occurred in the winter or spring, while west of this line the maximum has occurred invariably in one of the summer months. This line begins near the center of Long Island, crosses Connecticut east of New Haven and Massachusetts west of Worcester, and thence passes through Manchester, N. H., Lake Winnipesaukee and east of Mt. Washington to western Maine. The distribution of the monthly precipitation is such that, other things being equal, the yield of watersheds east of this line would be greater than those to the west of it.

It is evident from an inspection of the diagrams presented that the summer rainfall forms a much higher proportion of the annual precipitation in the northern and western valleys of New England than in the south and east, and as the yield of summer rains is much smaller than those of the winter and spring, the annual yield of watersheds in western and northern New England, other things being equal, is probably less in proportion to the total annual rainfall than in the southern and eastern districts. Variations due to other influences may modify somewhat the probable differences in stream flow indicated by the variations in the amount and distribution of the rainfall, and accurate continuous measurements

of rainfall and stream flow in northern New England watersheds, especially in the regions in which the amount and distribution of the rainfall differ greatly from those recorded on the watersheds of the carefully measured streams in southern districts, would be of great interest and value. It is of especial importance that more information be obtained as to the rainfall in the mountainous districts, concerning which very little is definitely known.

Variations in the Annual Rainfall.

Most important in their influence upon the flow of streams and yield of watersheds are the variations in the amount of the annual rainfall, and the questions whether the quantity is increasing or diminishing, whether changes in the amount occur at regular or irregular intervals, and the extent and limits of these variations are of great scientific and practical importance.

For the purpose of obtaining information relative to these questions, an effort has been made to secure the longest continuous series of observations of the rainfall in New England that is afforded by available records.

The earliest observations of the rainfall in New England, as previously stated, are those which were kept continuously by Professor Winthrop at Cambridge, Mass., for twenty-five years from August, 1749, until April, 1775, and by the use of these observations, supplemented with those of other observers, it has been practicable to obtain a nearly continuous record of the rainfall for the region about Cambridge from 1749 until the present time. The sources from which this record has been made up are described in detail elsewhere and need not be referred to here. The years for which observations are lacking are all included in the period from 1775 to 1791. In the first five of these years, 1775–1779, partial observations are available, and these have been used, supplemented with estimates based on a study of the diaries of the period. These diaries in their reference to the condition of crops, the height of water in lakes and streams, and the depth of snow, often give some idea as to the probable precipitation, so that it is possible to judge whether the precipitation of the period was marked by any very material divergence from the normal.

For the years 1780, 1781, 1787, 1788, 1790, and 1791, no records have been found. It is known that during four of these years, 1787, 1788, 1790, and 1791, observations of the rainfall were made at Cambridge by Professor Williams, and it is probable that these records, or some of them, will later be brought to light. It is also highly probable that records for parts if not all of the other years were kept by some of the observers either at Andover or Cambridge and will eventually be obtained.

For the present an estimate of the amount of rainfall in these years has been supplied by using the average rainfall for the entire period. In the period from 1792 to 1803, observations are available at Charlestown and Stow, and occasional observations at Andover, and these have been used in lieu of observations at Cambridge. Between 1804 and 1817 the only available records are those at New Haven, New Bedford, and Brunswick, Me., and it has been necessary to use these records, making such allowances as were deemed necessary for the difference in the geographical location and elevation of the stations.

In 1818 the records at Boston become available, and later on observations at other places, especially at Waltham, Lowell, Lynnfield, and still later the records at Cambridge itself.

In the presentation of diagrams showing variations in the amount of rainfall, progressive averages have commonly been used, made up in accordance with formulas which give varying weights to each successive year in a group usually of five years.

In the consideration of questions relating to the flow of streams, and especially the development of storage on New England watersheds, the reliable yield of a stream or reservoir is the amount of water that it is capable of supplying constantly in a period of deficient rainfall. In watersheds where the storage development is small in proportion to the size of the drainage area, this critical period may cover only a few months, while with great storage development it may extend over a period of from two to five years and possibly longer. In presenting a diagram of the variations in rainfall for the neighborhood of Cambridge from 1749 to the present time, a progressive average has been made by plotting the successive averages of the rainfall for three-year periods upon the ordinate representing the last year of the group. The results of

DIAGRAM
SHOWING PROGRESSIVE AVERAGE RAINFALL IN
EASTERN MASSACHUSETTS
1749 — 1913

Note The progressive average is made by plotting the successive averages of the rainfall for three year periods upon the ordinate representing the last year of the period

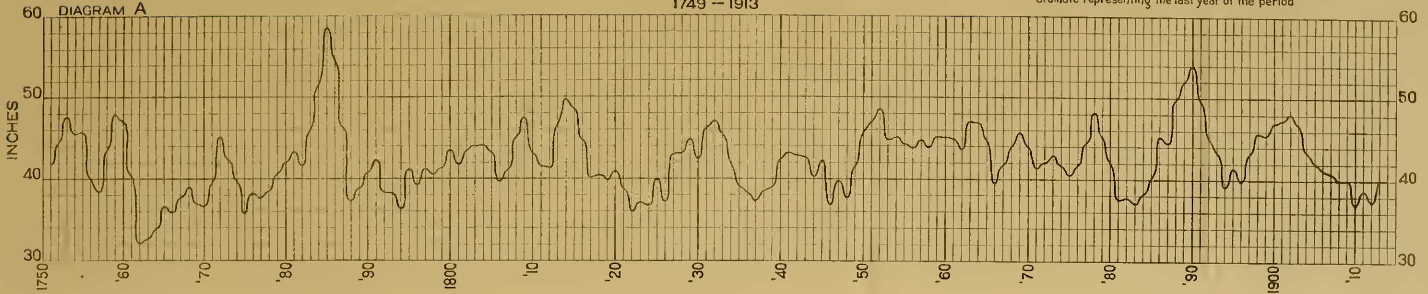
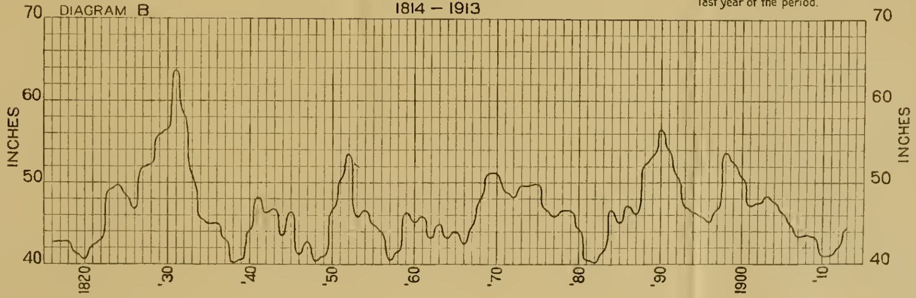


DIAGRAM
SHOWING PROGRESSIVE AVERAGE RAINFALL AT
NEW BEDFORD
1814 — 1913

Note - The progressive average is made by plotting the successive averages of the rainfall for three year periods upon the ordinate representing the last year of the period.



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this study, plotted in the manner described, are shown upon the accompanying Plate XXIII, Diagram A.

No evidence is shown by this long record that the rainfall in New England is either increasing or diminishing, nor are there any indications of a regular variation in the annual quantity. So far as this record shows, the variations in the annual rainfall are usually short and quite irregular, though the amount may at times remain below or above the average for many years, as in the period from 1832 to 1849, when the amount was almost continuously below the normal for seventeen years, or in the period from 1850 to 1863, when it was almost continuously above it. The periods of continuously high or low rainfall are usually short, averaging from five to seven years.

The most striking of the variations from the normal are the excessive rainfalls in the periods 1783–1785 and 1888–1890 and the great deficiency in 1760–1762. The maximum annual rainfall in the entire one hundred and sixty-five years occurred in 1785 and amounted to 62.40 in.

With the exception of the excessive rainfalls of 1783–85 and 1888–90, occurring almost exactly one hundred years apart, the maximum rainfall in the region of Cambridge has never equaled an average of 50 in. for a three-year period, and with the two exceptions indicated a maximum of 48 in. for three years has been reached but five times, though in four other periods the maximum has exceeded 47 in.

In the period of three years of lowest rainfall, 1760–62, the average amount fell to a little over 32 in. per year, and the rainfall for the minimum year, 1762, amounted to 24.47 in. Next to that period the lowest average occurred in the period of 1820–22, when the average was a little over 36 in. for three years and the rainfall for the minimum year, 27.20 in.

The average rainfall at Cambridge for the whole period from 1749 to date, computed from records compiled in the manner described, is 42.31 in., and the average rainfall for the past forty years, 1873–1912, is 43.02 in., or about 1.7 per cent. higher than the average for the entire one hundred and sixty-five years. This difference under the circumstances is insignificant. The rainfall for the minimum year, as already indicated, was 24.47 in., and for

the maximum, 62.40 in. In the last forty years the rainfall in the minimum year was 31.35 in., and in the maximum, 59.39 in.

Next to the long record that it has been practicable to compile for the region in the neighborhood of Cambridge, the longest continuous record of rainfall observations in New England is that at New Bedford, which covers a period of one hundred years. A progressive average of the annual rainfall at New Bedford for three years is shown on Plate XXIII, Diagram B. These observations were made in a district having a considerably higher normal rainfall than occurs at Cambridge, and a comparison of the variations in the rainfall at these stations is of much interest.

The diagram of the rainfall at New Bedford shows in a general way much the same gradual rise and fall in the average rainfall for three-year periods that is shown by the Cambridge diagram already considered.

The greatest average rainfall for three successive years at New Bedford occurred in 1829–31, when the average precipitation amounted to 63.7 in. per year. In 1888–90 the average was 56.5 in. The former quantity is somewhat higher, even allowing for the difference in normal, than occurred in the neighborhood of Cambridge in 1783–1785, which was 58.7.

The minimum rainfall for any three years shown by these observations occurred in the three years 1836–1838, when the amount fell to 40 in. The next lowest occurred in 1880–82, when the amount was 40.2 in.

The average rainfall at New Bedford for the century covered by the observations was 46.47 in., and for the past forty years, 46.65 in.; that is, as in the case of Cambridge, the rainfall for the past forty years has been very slightly higher than the average for the entire one hundred years. The maximum rainfall for the entire period was 65.41 in., in the year 1829, and the minimum, 34.51 in., in the year 1846. During the past forty years the maximum rainfall was 62.60 in. in 1898, and the minimum, 36.81 in., in 1885.

The periods of maximum and minimum rainfall are somewhat more sharply defined than at Cambridge, and it is possible to divide the table of yearly rainfall into quite definite periods of maximum, minimum, or average precipitation which show the

approximate periodic variations at this station for the past century. The average length of the periods is from seven to eight years. These periods and the average amount of rainfall in each are shown in the following tables.

Table showing Groups of Dry, Wet, and Average Years at New Bedford.

Period.	No. of Years.	Average Rainfall per Year.
1814–1822	9	42.28
1823–1832	10	54.26
1833–1839	7	42.79
1840–1843	4	47.48
1844–1849	6	41.06
1850–1854	5	50.74
1855–1866	12	43.23
1867–1878	12	48.91
1879–1885	7	42.59
1886–1890	5	54.22
1891–1895	5	45.69
1896–1904	9	49.45
1905–1913	9	42.87

Placing these periods in the order of the average amount of rainfall from the least to the highest, the results are shown in the following table.

Period.	No. of Years.	Average Rainfall per Year.
1844–1849	6	41.06
1814–1822	9	42.28
1879–1885	7	42.59
1833–1839	7	42.79
1905–1913	9	42.87
1855–1866	12	43.23
1891–1895	5	45.69
1840–1843	4	47.48
1867–1878	12	48.91
1896–1904	9	49.45
1850–1854	5	50.74
1886–1890	5	54.22
1823–1832	10	54.26

The variations in the amount of the annual rainfall at many other stations at which records have been kept for long periods are similar to those noted at New Bedford.

Maximum and Minimum Rainfall.

In the determination of the probable heights of freshets in New England rivers many other circumstances than differences in the amount of the annual or monthly rainfall enter into the calculation, such as the season of the year, rate of precipitation, condition of the ground — especially the presence or absence of snow, character of the watershed, etc., and in making comparisons of periods of maximum rainfall for the purpose of estimating their probable effect upon the flow of streams, careful consideration must be given to the conditions which are likely to affect materially the proportion of the rainfall which will enter the streams. For example, the great rain of February 10–14, 1886, in which the total precipitation reached or exceeded 8 inches in southeastern Massachusetts and portions of Rhode Island, produced the most destructive freshet ever recorded in southeastern New England, while an equal amount of rain in a much shorter time on October 11 and 12, 1895, had little effect beyond a slight flooding of low lands. In the former case the rain occurred in winter when the reservoirs and ponds were for the most part well filled, and the frozen ground was covered deeply with snow, while in the latter case the rain occurred in the early autumn after a long period of dry weather and at a time when the reservoirs were considerably depleted. Under the conditions existing in New England, a comparison of annual or monthly rainfalls in different periods is of little value as an indication of the comparative heights of freshets unless allowance is made for other important conditions which may greatly modify the effect of a high rainfall.

On the other hand, the rainfall in periods of extreme drought furnishes a very fair basis for estimating the comparative flow of streams in such periods, but even here variations in the distribution of the rainfall in the different seasons of the year, in the amount of precipitation that occurred in previous periods, and other circumstances, might produce a considerable difference in the yield of a watershed in two periods having the same total rainfall. The best method of estimating the probable comparative flow of streams in periods of drought by the use of the rainfall observations alone is to compare the precipitation month by month, since a rainfall of 5 or 6 in. in the months of March or April would

ordinarily mean a flow in the streams many times as great as would an equal quantity in the months from July to October, as has already been indicated by the diagram showing the comparative rainfall and run-off in the Sudbury and Croton river watersheds.

Nevertheless, a comparison of the annual rainfall in periods of great deficiency furnishes in a general way a measure of the probable comparative flow of streams in such periods, and a comparison of the monthly records can be made in cases where more definite information is desired.

From an inspection of the diagram showing the rainfall at Cambridge by three-year periods from 1749 to the present time, it appears that the period of lowest rainfall occurred in the years 1760–62, but the dry period in which these years occurred extended almost continuously from 1760 to 1775 and probably included a few subsequent years. While the lowest rainfall for three years occurred in 1760–62, the rainfall in several subsequent groups of years in this period was also very low, as, for example, the period from 1761–63, with an average of 32.59 inches; 1773–75, with an average of 35.77 inches; and 1764–66, with an average of 35.80 inches. The ground water levels must have fallen very low in the period from 1760–63, and it is not at all improbable that, even with a somewhat higher rainfall, the flow of streams in 1764–66 was nearly or quite as low as in the period 1760–62.

In no other group of years are the rainfalls as low as in the years 1760–75 as recorded by Professor Winthrop. Next in order of dryness to the years included in Professor Winthrop's records are the dry periods of 1820–26, in which the minimum three years was 1820–22, with an average rainfall of 36.09 inches. Then come 1792–94, with an average rainfall of 36.36 inches; then, the years 1844–49, with a minimum rainfall in 1844–46 of 36.89 inches, and then the period of 1908–12, with a minimum rainfall in the period 1908–10 of 37.06 inches. This period differs but little, however, from the period 1879–83, with a minimum of 37.09 inches in the years 1881–83, and the period 1835–39, in which the minimum was 37.44 inches in the years 1835–37.

It is probable, judging from these records, that lower flows of streams occurred in the neighborhood of Cambridge in 1820–22 and 1792–94 than in the dry years of recent experience, and it is

also probable that there were at least two other periods in which the deficiency was as great as in recent years, but the records of the great drought of 1760–62 show a rainfall far lower than any other that has occurred in Cambridge in a period of one hundred and sixty-five years. Judging from these records, such droughts as that of recent experience may be expected to occur on an average as often as once in twenty years, and at very long intervals there may be periods of much greater drought.

At New Bedford the periods of low rainfall were similar to those at Cambridge. The period of lowest rainfall occurred in 1836–39, the lowest average precipitation for three years being 40.06 inches in 1836–38. The next lowest period was that of 1879–83, with a minimum of 40.48 inches in the years 1880–82. Next in order comes the period 1844–49, with a minimum rainfall of 40.39 inches in the years 1846–48, and then the period 1817–20, with a minimum of 40.58 inches in 1818–20. In the period of 1855–58 very low rainfalls were recorded at New Bedford, the lowest being an average of 40.46 inches in the years 1855–57. This period does not appear to have been a seriously dry one in most parts of New England. The lowest rainfall in the period 1908–12 occurred in the years 1908–10, with an average for three years of 40.84 inches. In this case, also, drier periods than those of recent years have occurred in the past, and as many as six periods of approximately equal or greater deficiency in rainfall have occurred during the century covered by these records, an average of one in about seventeen years, though three such periods occurred in the twenty years between 1836 and 1856.

A study of the records of rainfall at other stations shows similar results, but if periods of less than three years are considered, the number of very dry periods is increased and the relative average rainfall at each is in some cases considerably modified. A consideration of these shorter periods at other stations than Cambridge and New Bedford indicates the occurrence of very dry periods in a large part of New England in 1863–64 and 1893–94, as well as others in earlier times.

Judging from a comparison of the available rainfall records for the eighty years from 1833 to 1912, the year 1846 was by far the driest thus far recorded throughout a very large part of New England.

As already stated, the conditions affecting the distribution of the rainfall appear to act quite uniformly throughout the greater part of New England, and a year of deficient rainfall which affects seriously a portion of the area usually affects the greater part of it, but there is considerable variation in the distribution of the rainfall even in very dry years, and in consequence the notable droughts of the past forty years have varied somewhat in intensity from place to place. For example, the year 1880 was probably the year of least rainfall in the last forty years in a considerable area in central and southern New Hampshire and a small portion of Vermont, and it was also probably the driest year in small portions of western Connecticut and adjacent sections of New York. The year 1883 was a year of severe drought in parts of central and south-eastern Massachusetts and in the Connecticut River valley in Connecticut, and in adjacent portions of New York, while the year 1894 was probably the driest recorded in certain sections of northern Connecticut, western Massachusetts, the southern parts of Vermont and New Hampshire, and throughout the extreme northern and eastern parts of New England. In other large sections, the rainfall of 1908 or 1910 was lower than in any of the past forty years.

In comparing the total rainfall in the periods of two or three years in which these years of great drought have occurred, it will be found that the differences in the amounts are not great and the comparative flow of a stream in each of these periods probably depended to a considerable extent upon the seasonal distribution of the rainfall.

Summary.

The results of this study as a whole show very clearly that, so far as it is possible to judge from available records, which cover at the longest a period of one hundred and sixty-five years, there are no indications that a notable increase or decrease is taking place in the rainfall of New England, nor is there any marked evidence of material change in its seasonal distribution. Permanent changes in the amount of the rainfall, if they are occurring, probably take place very slowly through a very long period of time, compared with which the period covered by recorded observations is insignificant.

As to the occurrence of periodic variations of considerable length, the available records do not appear to furnish a reliable basis for definite conclusions. As a rule, so far as these records show, the amount of the rainfall fluctuates frequently with little apparent regularity, and periods of high or low rainfall rarely continue for fifteen years, while their average duration is from five to eight years. The results recorded in some cases appear to indicate a steadily increasing or decreasing rainfall for periods of many years, as, for example, the constant increase at Providence, R. I., for forty years — 1837–77, and at New York for twenty-eight years — 1842–69, or the constant decrease at Albany, N. Y., for forty years — from 1871 to the present time; but these indications appear to be exceptional.

Nevertheless, it is true that dry periods such as that of recent experience and of even greater intensity occurred with comparative frequency in the first half of the nineteenth century, while in the last half of that century — from 1850 to 1902 or 1903 — there were only two or three periods of great drought, none of which probably was as severe as those of the earlier time or in the years of recent experience. If this circumstance indicates a periodic variation in the amount of the rainfall covering periods of about fifty years, as has been suggested by some of the students of the subject, then many years of low rainfall lie immediately before us.

Dry periods such as that of 1908–11 have occurred three or four times during the past sixty years but were apparently of much more frequent occurrence during the early half of the nineteenth century. From the longer records, such periods may be expected to occur on an average once in fifteen to twenty years and may occur as often as at intervals of ten years, or even less. The droughts of the earlier half of the nineteenth century, especially in 1822, 1837, and 1846, which followed in each case several years of deficient rainfall, were probably more serious than those of more recent times. The recurrence of such periods would probably reduce the flow of streams to smaller amounts than have been recorded since observations of stream flow were begun in New England.

The great drought in 1760–62 was probably the most severe that has occurred in New England since observations of the rainfall were first begun there, and the recurrence of another such

period of low rainfall would undoubtedly prove far more disastrous than in that earlier time, when public water supplies were practically unknown and stream development had hardly begun, though the contemporary records show that the effects of this great drought were serious enough to the people of that day.

Under present conditions in New England, the development of water supplies for any purpose to an extent sufficient to meet such a drought as that of 1760–62 may seem hardly to be justified, but periods such as those of 1821, 1837, and 1846 must be expected to recur, and with rainfalls as low as were recorded very generally throughout the greater part of New England in those years, a materially greater reduction would probably be made in the flow of streams and in the storage in lakes and reservoirs than has been experienced in recent times.

The intensity of droughts varies from place to place and, while the great drought of 1908–11 caused a lower flow in the streams in some sections in New England than any other for the past sixty years, the indications are that in other sections one or another of the previous droughts in this period, such as that of 1893–95, or 1880–83, was more severe.

It is evident that much more complete observations of the rainfall than are being recorded even at the present time are necessary for the satisfactory determination of many of the questions relating to the flow of streams and yield of watersheds in different parts of New England. In the mountain regions, especially in central and northern Maine, in and about the White Mountains of New Hampshire, and in the Green Mountains of Vermont, Massachusetts, and Connecticut, observations of the precipitation at more numerous stations properly distributed would furnish information of very great interest, and not less interesting would be a more thorough observation of the rainfall along the coast for the study of the causes of the great variations in rainfall that apparently occur in these regions within very narrow limits. It would be a great advantage, also, if complete records of the observations now made were more readily available for the use of those interested in this subject. Observations are made at several stations by the national government, and many valuable records are being collected by colleges and academies, by state and muni-

cipal water departments, and by water supply and water power companies and others, but many of these observations are published, if at all, only in public or private reports and annals, from which they must be collected if the observations are to be made available for study. Furthermore, many valuable observations are being made by corporations and private individuals which are not always accessible to the public.

At the present time, with the great developments that are taking place in the uses of lakes and rivers, not only for water supplies and industrial enterprises, but for the irrigation of crops and other purposes, thorough and accurate information as to the rainfall and stream flow is becoming of the greatest practical importance, and in order to supply satisfactory information relating to these questions, more numerous and careful observations are required than are being made at the present time. The work done by the New England Meteorological Society was very valuable in stimulating an interest in matters relating to climate and rainfall, in extending the number of observations, and especially in securing prompt comparisons and discussions of results, which aided greatly in the maintenance of complete and accurate observations. The work of the weather service has not fully filled the place of that society in these important respects, and it would aid greatly in the advancement of knowledge relating to this subject if a local organization similar to the New England Meteorological Society coöperating with the weather service should again take up this important work.

Rainfall Tables — Explanatory Note.

The records of rainfall in New England presented in the following tables are arranged by states in the following order: Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut. Observations in adjacent portions of New York and of Canada follow in the order named.

As a general rule, the stations in each state are arranged alphabetically by towns, but in a few cases where the name of the station is better known in connection with rainfall observations than that of the town, — as in the case of Bar Harbor, Me., if placed under the name of the town of Eden, — or where confusion

might arise, — as in the case of Chestnut Hill, Mass., if placed under Boston, — the name of the station is used instead of that of the municipality in which it is located.

In cases where the observations have been made by the Weather Bureau or are reported regularly to that office, the name of the observer is not usually given, since a list of the observers is printed in the Weather Bureau reports. In cases where the observation is made by a water department or a corporation, the name of the department or corporation is usually given, and in cases of private observers the name of the observer — where known — is printed at the head of the table.

In considering rainfall observations, the elevation of the gage above the sea is a very important point, and the elevation has been given at the head of each table in practically all cases.

The elevations wherever possible have been taken from Weather Bureau records. In other cases the elevations have been obtained from the reports of water-works officials or officials of corporations having charge of the observations. Where no other information has been found to be available, the elevations have been obtained from the maps of the United States Geological Survey and are necessarily only approximate.

In making up the tables it has been practicable in a few cases to secure access to the original records, and in all such cases the figures given are those of the original record. The number of cases in which original records have been accessible are comparatively few, however, and usually dependence has had to be placed on a published record. Many of the older records have been published in many places, and comparisons of a given record in different publications sometimes show considerable differences. In such cases the record presented is that which appeared after examination to be the more reliable. It will consequently be found that some of these records differ from those presented in available publications, and in a few cases the records as printed in the reports of the Weather Bureau have been rejected where these records appear to follow a less reliable source of information than another which is available.

In the course of the inspection of rain gages, of which many have been examined, a number have been found defective. Where

practicable, a standard gage has been set up in the neighborhood of the defective gage to determine the amount of error, and where this difference has been fairly constant for a considerable time a correction for the record is given in a note appended to the table. In one or two other cases where an error in measurement had been made, due to the use of a measuring vessel of different capacity from the amount assumed, the error has been corrected and the correction usually noted in the tables.

Comments as to the accuracy of the tables have not been presented, except in cases where definite reasons for doubting the accuracy of the tables have been given.

Many of the records of rainfall observations, some of them among the longest and most valuable, are incomplete, and periods ranging from one month to several years are sometimes lacking. In most cases figures have been interpolated from other records at stations where the conditions appear to be similar. These interpolated figures are printed in heavy type and have been used in making up the average given at the bottom of the table. These averages include all of the years given in the table for which the record is complete in the original or has been completed by these interpolations.

A few records of rainfall observations in New England have been omitted from the tables. These are chiefly fragmentary or defective records or observations which cover a very short period of years and which have been discontinued. In a few cases where observations have been made for a considerable period of years in the immediate neighborhood of a station covering a much longer period which includes the years covered by the shorter record, the latter has been omitted, unless differences in elevation or some other circumstance gives it value.

All of the older records, however, even though fragmentary or covering very short periods, have been included, as, for example, the observations for a year and a half at Ipswich in the latter part of the eighteenth century, and the earlier observations at New Haven, Conn., and Brunswick, Me., etc. Such observations have also been included in regions where no other records of precipitation have been found.

MAINE.

RAINFALL AT BAR HARBOR, ME. Elevation, 20 feet.

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1871	2.95	3.50	2.39	3.05	3.55	2.18	4.10	5.75	3.95	6.30	8.35	3.83	49.90
1872	3.93	2.69	5.99	4.30	5.20	**5.96**	4.00	6.95	4.40	6.75	7.92	5.83	63.92
1873	5.39	3.12	4.24	4.75	3.80	2.80	3.10	1.25	4.47	5.31	5.62	7.33	51.18
1874	7.28	4.90	4.00	2.70	4.20	6.55	5.35	5.55	3.80	2.80	6.07	3.90	57.10
1875	0.24	5.32	5.06	4.30	2.10	3.95	5.50	2.10	3.32	**5.51**	5.30	2.86	45.56
1876	8.11	6.05	**7.34**	3.51	2.70	3.60	7.90	1.70	3.65	8.10	3.77	4.58	61.01
1877	3.74	1.75	9.04	2.53	3.15	3.70	4.29	2.25	1.70	**5.11**	5.20	**2.08**	44.54
1878	4.76	3.46	0.78	**5.57**	1.70	5.70	2.95	6.95	**1.94**	5.70	**3.35**	5.79	48.65
1879	**1.97**	1.52	**4.09**	**3.81**	1.60	4.62	4.20	3.65	2.60	3.50	**4.71**	**3.53**	39.80
1886	9.29	5.89	3.28	1.07	3.90	1.75	1.51	1.44	2.58	2.58	5.74	3.30	42.33
1887	8.22	7.29	5.03	4.81	1.11	2.58	3.48	6.61	0.60	3.53	3.85	5.11	52.22
1888	4.81	4.77	4.02	3.00	3.67	1.53	3.24	4.29	6.36	7.84	7.60	5.98	57.11
1889	4.83	3.88	4.42	2.81	1.79	2.04	2.07	1.17	1.65	5.86	6.25	5.92	42.69
1890	3.64	3.64	6.31	1.82	10.81	3.15	0.99	5.93	4.25	3.12	2.59	6.13	52.38
1891	7.21	4.68	5.18	2.87	1.57	3.73	4.36	2.45	2.15	4.76	3.12	**4.05**	46.13
1892	**5.71**	**2.25**	**3.19**	1.34	2.25	4.43	1.01	5.09	1.79	1.17	5.11	2.33	35.67
1893	3.34	3.59	1.72	3.64	4.25	2.17	3.57	4.14	3.18	4.66	2.23	7.19	43.68
1894	3.46	1.47	1.46	1.59	4.33	1.50	1.99	1.65	4.17	4.96	**2.57**	**3.00**	32.15
1895	**4.62**	**1.54**	**2.98**	**3.16**	1.59	1.63	1.79	2.64	2.29	1.42	9.73	3.08	36.47
1896	1.47	5.50	6.32	1.19	2.96	2.39	6.05	2.90	6.04	5.85	5.10	2.60	48.37
1897	4.82	2.29	3.54	2.75	6.36	4.00	5.62	8.22	2.33	0.35	9.25	4.35	53.88
1898	6.45	9.15	2.95	4.85	2.45	3.27	1.70	2.92	3.55	9.25	8.35	3.60	58.49
1899	5.52	4.05	7.15	1.09	2.25	1.36	6.55	0.75	3.80	3.05	5.65	2.57	43.79
1900	11.15	6.20	8.57	3.15	6.07	3.52	1.65	1.90	3.15	6.77	5.48	2.43	60.04
1901	4.83	1.63	10.30	5.81	2.74	3.23	1.63	3.00	3.28	3.45	3.50	9.78	53.18
1902	4.05	3.83	14.37	3.07	2.52	7.60	1.75	3.24	2.50	5.11	1.79	7.12	56.95
1903	5.83	5.30	10.05	3.65	1.65	8.23	3.25	0.75	1.68	5.28	3.97	3.35	47.99
1904	5.37	4.05	5.37	5.02	4.62	1.40	1.72	5.24	9.81	2.55	2.25	3.63	51.03
1905	5.20	3.20	1.05	0.95	3.20	4.54	3.35	2.56	7.79	2.10	7.22	7.61	48.77
1906	4.46	2.70	8.10	4.33	4.78	2.25	2.28	0.75	1.40	4.40	4.10	4.55	44.10
1907	3.00	3.45	2.00	5.30	2.90	4.48	3.05	2.37	5.90	4.90	5.30	5.75	48.40
1908	5.39	5.88	3.40	3.25	3.75	1.65	3.50	2.23	2.25	5.55	1.69	5.95	44.59
1909	7.10	6.07	5.85	5.11	4.28	1.15	2.66	1.53	8.35	1.81	5.77	2.03	51.71
1910	3.30	5.40	3.10	5.17	1.75	1.15	1.00	2.65	1.12	1.01	2.00	4.25	34.90
1911	4.55	4.14	4.35	1.70	T	3.51	1.41	1.90	5.15	2.10	6.65	4.30	42.76
1912	5.75	4.60	5.95	3.70	8.75	1.18	4.50	3.93	3.88	4.95	5.73	6.17	59.39
1913	4.13	3.35	7.85	2.64	3.56	0.10	3.38	1.88	2.15	9.54	1.00	4.70	44.28
Av.	5.02	4.11	5.16	3.33	3.46	3.15	3.34	3.25	3.59	4.52	4.97	4.62	48.52

RAINFALL AT BELFAST, ME. Elevation, 165 feet.

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1891	...	...	...	...	...	3.33	4.16	3.32	1.55	2.97	3.02	5.10	. .
1892	5.65	2.61	2.77	0.93	2.71	4.50	1.62	5.38	2.70	1.26	4.86	1.70	36.69
1893	3.99	4.84	2.05	3.21	5.29	2.73	2.99	3.82	4.35	4.48	2.16	7.45	47.66
1894	4.37	3.65	1.58	1.63	5.86	1.98	1.46	4.72	4.61	5.56	2.52	3.83	44.77
1895	6.53	1.15	3.06	4.03	2.05	3.19	1.94	1.96	1.13	1.82	7.29	1.63	39.08
1896	0.98	5.01	7.30	1.18	3.03	2.21	5.19	5.02	10.32	3.25	4.25	1.40	49.14
1897	3.98	2.32	4.65	2.90	5.02	3.08	3.19	3.92	2.09	0.90	5.75	3.50	41.30
1898	5.81	11.35	2.48	4.67	1.28	4.69	1.38	2.31	3.17	8.35	5.59	2.96	54.04

RAINFALL AT BELFAST, ME. — *Continued.*

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1899	3.73	2.76	5.86	1.79	2.25	2.09	4.73	0.50	4.80	3.03	2.94	2.90	37.38
1900	5.68	8.19	7.31	2.26	7.18	4.34	**1.76**	**2.33**	3.05	5.04	5.41	1.68	54.23
1901	4.51	2.16	7.80	6.49	2.09	0.88	3.10	3.64	2.50	3.53	3.11	9.74	49.55
1902	3.37	2.59	12.70	3.09	1.85	6.38	1.52	4.62	1.84	5.05	1.34	4.90	49.16
1903	4.96	5.13	8.94	1.45	0.53	3.51	4.12	2.69	0.84	3.99	2.46	4.26	42.88
1904	4.86	1.84	3.14	5.06	6.51	1.03	1.23	4.66	6.30	2.91	**2.32**	**2.95**	42.81
Av.	4.50	4.12	5.36	2.97	3.51	3.12	2.86	3.51	3.69	3.78	3.87	3.99	45.28

RAINFALL AT BRIDGTON, ME. Elevation, 450 feet.
(North Bridgton.)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1894	1.64	2.24	2.51	1.88	6.40	2.61	2.90	3.59	5.90	4.65	**2.66**	**2.99**	39.97
1895	1.92	1.08	1.73	6.86	2.74	3.49	2.74	2.98	2.41	2.91	6.58	5.79	41.23
1896	0.97	8.12	10.70	1.90	2.88	2.09	3.54	3.72	6.26	3.12	5.08	1.67	50.05
1897	4.59	3.17	4.74	2.93	5.47	6.00	13.25	3.35	2.76	1.14	5.79	4.76	57.95
1898	5.76	7.26	1.11	3.53	2.39	4.19	5.42	2.46	3.09	4.33	6.10	3.19	48.83
1899	3.38	3.98	6.58	1.81	0.80	2.42	5.35	1.86	3.95	1.56	2.46	2.18	36.33
1900	6.44	9.06	6.55	0.96	3.93	1.64	2.95	2.16	3.27	4.22	6.70	1.42	49.30
1901	**3.11**	1.70	4.80	7.60	7.56	3.91	5.13	5.46	2.55	3.24	2.14	5.75	52.95
1902	4.36	2.55	8.21	4.67	3.98	5.50	2.66	4.21	4.11	5.72	1.78	6.27	54.02
1903	4.20	4.02	5.62	2.02	0.54	6.38	3.45	2.88	2.16	4.04	1.02	3.36	39.69
1904	4.58	2.46	3.47	5.90	4.31	2.87	2.96	5.91	4.25	1.70	1.33	1.67	41.41
1905	4.67	1.66	2.06	1.65	2.16	5.50	5.97	2.53	7.02	1.56	3.16	2.95	40.89
1906	2.77	1.52	3.87	2.36	4.66	6.13	5.82	1.79	0.83	5.18	3.36	4.32	42.61
1907	1.90	1.89	3.68	3.80	2.21	4.28	2.95	2.10	6.49	4.49	4.74	3.67	42.20
1908	2.43	3.65	2.20	2.58	4.51	1.00	5.34	3.55	0.81	2.40	1.46	3.27	33.20
1909	6.12	5.79	3.78	3.68	3.55	2.42	2.00	1.51	6.13	1.34	2.71	2.95	41.98
1910	3.77	4.48	1.65	4.92	3.20	3.28	1.35	5.72	4.15	3.13	2.51	3.63	41.79
1911	2.75	2.56	4.31	0.91	1.35	2.88	3.89	2.82	3.63	2.82	3.21	2.97	34.10
1912	3.12	2.41	5.13	2.90	5.17	1.20	2.95	3.55	3.82	3.81	3.84	2.62	40.52
1913	3.23	2.31	4.23	2.31	4.71	1.40	2.03	2.47	4.16	5.69	2.78	2.96	38.28
Av.	3.58	3.59	4.35	3.26	3.63	3.46	4.13	3.23	3.89	3.35	3.47	3.42	43.36

RAINFALL AT BRUNSWICK, ME. Elevation, 70 feet.

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1808	...	...	...	3.03	6.85	4.51	4.69	5.69	3.43	4.12	3.58	7.34	....
1809	3.20	2.15	2.90	0.05	2.93	3.60	5.45	2.48	5.31	2.15	7.18	4.91	42.31
1810	0.20	0.30	5.40	2.20	2.09	2.78	2.99	3.58	1.38	1.40	4.57	1.20	28.09
1811	0.50	4.50	...	...	4.30	2.00	4.00	3.61	0.51	2.61	7.72	1.30	....
1812	1.95	3.00	0.90	4.91	4.50	6.72	5.02	3.69	1.00	4.58	2.84	1.60	40.71
1813	2.90	2.15	5.08	2.80	2.74	2.98	3.28	2.14	0.67	6.08	6.07	0.55	37.44
1814	0.60	1.50	2.50	4.93	11.40	3.60	3.45	7.31	5.07	0.54	3.95	3.35	48.20
1815	2.37	1.85	1.16	2.76	1.80	4.75	1.49	3.02	**2.51**	1.22	1.62	2.35	26.90
1816	3.24	2.41	0.63	1.20	4.15	1.41	1.60	2.13	0.30	5.99	5.49	**0.70**	29.25
1817	5.75	4.10	1.95	1.94	0.52	5.09	2.16	3.35	**4.09**	2.55	4.70	4.15	40.35
1818	4.40	1.40	3.60	1.20	5.80	1.37	2.98	0.16	5.07	0.00	0.20	0.20	26.38
1819	...	1.80	5.00	2.20	...	...	...	...	...	...	0.30	...	....
1820	...	...	0.30	...	...	...	...	...	...	...	0.90	1.05	....
1821	0.50	2.10	1.60	0.60	...	...	...	...	...	...	...	3.10	....
1822	0.40	1.70	...	...	...	...	...	...	...	...	...	0.60	....

RAINFALL AT BRUNSWICK, ME. — *Continued.*

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1823	1.90	3.70	3.80	0.60	...	...	...	...	...	...	...	2.80	....
1838	...	...	...	...	...	...	...	...	...	...	...	0.90	....
1839	2.45	4.90	6.08	6.19	4.06	4.32	8.43	7.04	2.18	1.02	4.10	3.42	54.19
1840	0.91	2.25	1.81	6.00	2.10	2.83	1.70	5.82	2.34	1.71	4.45	4.20	36.12
1841	4.20	1.40	4.40	9.15	3.27	1.85	1.80	0.52	7.60	2.00	3.99	8.00	48.18
1842	3.82	5.69	5.48	3.75	2.64	3.00	5.21	5.73	4.88	0.71	6.04	8.03	54.98
1843	4.15	7.28	7.75	9.02	3.83	3.92	3.26	12.21	0.88	7.30	5.23	2.10	66.93
1844	3.85	0.80	7.98	0.28	5.13	2.83	2.06	4.24	2.93	7.58	4.76	7.88	50.32
1845	8.06	3.57	3.13	2.66	6.53	2.26	8.67	4.41	3.85	4.86	17.75	9.89	75.64
1846	5.54	1.80	11.28	2.09	1.88	2.67	4.58	2.05	1.40	1.95	3.85	4.37	43.46
1847	5.95	5.60	2.40	5.07	3.14	6.64	2.75	6.63	5.49	4.77	5.78	6.95	61.17
1848	5.93	2.24	6.12	1.53	10.03	3.75	4.20	3.33	6.34	7.67	3.48	4.75	59.37
1849	1.85	1.40	4.15	3.50	2.70	3.62	1.72	7.82	2.40	3.40	3.65	3.10	39.31
1850	3.43	1.73	3.38	5.00	17.57	4.99	2.72	4.37	2.93	4.74	2.62	3.96	57.44
1851	3.89	2.74	0.80	6.01	2.37	4.80	4.78	0.97	2.11	9.34	5.89	3.67	47.37
1852	3.06	6.90	3.69	7.83	1.20	3.15	2.97	6.03	2.90	3.23	7.23	7.08	55.27
1853	...	...	...	...	...	...	...	...	...	...	...	...	....
1854	2.75	4.87	2.70	0.65	8.86	5.66	3.45	0.28	2.53	1.30	10.19	2.90	46.14
1855	5.68	0.50	0.50	2.75	2.78	4.57	4.37	4.80	1.40	9.73	3.40	4.10	44.58
1856	2.50	0.50	1.30	1.72	3.40	2.05	3.07	6.32	2.55	3.59	2.05	3.73	32.78
1857	3.10	2.60	4.90	5.29	3.43	3.45	2.40	5.78	0.70	5.05	2.08	4.10	42.88
1858	4.30	2.08	1.80	3.67	5.52	1.95	6.41	7.76	3.79	3.09	3.32	1.85	45.54
1859	3.60	2.10	8.15	2.70	3.59	7.35	1.35	2.12	5.89	1.75	4.45	5.39	48.44
Av.	3.57	2.75	3.86	3.68	4.48	3.72	3.60	4.35	3.12	3.77	4.86	4.09	45.85

RAINFALL AT CALAIS, ME. Elevation, 120 feet.

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1889	4.17	**4.13**	3.59	3.02	1.81	3.33	3.24	2.87	1.93	4.72	**4.60**	4.33	41.74
1890	3.95	4.41	6.19	2.01	8.63	3.21	2.59	7.90	5.24	2.27	2.27	5.79	54.46
1891	9.52	3.91	4.39	2.95	2.82	3.72	3.50	3.45	3.53	5.78	3.88	3.74	51.19
1892	5.30	5.20	6.40	1.56	2.02	5.77	2.07	4.64	1.71	2.22	6.75	1.63	45.27
1893	3.49	3.22	1.35	2.20	2.61	1.82	3.54	3.84	3.23	3.97	2.21	7.73	39.21
1894	3.04	1.55	2.18	1.32	2.14	2.52	2.24	2.88	3.13	5.07	3.53	3.83	33.43
1895	5.68	1.40	2.52	4.23	2.51	1.75	2.75	2.60	1.16	3.66	**7.29**	**4.63**	40.18
1896	**0.98**	**5.01**	**7.30**	**1.18**	**3.03**	**2.21**	**5.19**	**5.02**	5.69	4.09	4.16	2.39	46.25
1897	4.74	1.63	4.65	3.86	5.53	3.45	4.75	4.71	2.49	0.44	6.35	2.93	45.53
1898	5.42	8.25	2.29	4.56	1.69	4.48	1.14	2.98	3.19	7.72	6.82	2.41	50.95
1899	1.75	3.62	5.23	0.62	3.89	3.10	4.23	0.78	2.87	2.57	3.85	3.48	35.99
1900	5.59	7.85	5.65	3.84	8.11	1.30	2.31	1.49	3.21	10.87	5.61	2.05	60.88
1901	5.30	1.80	5.29	7.85	2.02	3.55	1.11	4.45	2.72	3.23	2.31	8.07	47.70
Av.	4.53	4.00	4.39	3.02	3.60	3.32	2.97	3.66	3.08	4.36	4.59	4.08	45.60

RAINFALL AT CORNISH, ME. Elevation, 778 feet.

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1857	2.40	5.12	4.90	9.45	6.25	0.85	3.41	7.17	0.25	9.71	2.22	2.41	54.14
1858	**4.02**	1.65	2.95	3.34	3.69	3.78	8.01	2.75	4.19	5.76	3.16	1.30	44.60
1859	4.10	2.75	10.05	3.24	2.38	6.75	2.00	3.19	3.82	2.03	4.30	4.50	49.11
1860	1.65	3.32	3.01	1.85	1.80	5.20	4.00	6.86	3.10	4.90	8.70	3.17	47.56
1861	4.94	2.95	5.15	4.15	4.30	2.20	3.80	1.60	3.40	6.50	4.35	2.10	45.44
1862	4.25	3.80	3.55	2.80	1.95	4.60	6.00	2.75	0.90	3.55	5.15	0.85	40.15
1863	1.40	2.37	2.25	5.40	1.56	1.50	7.30	4.70	2.50	3.60	4.90	5.50	42.98

RAINFALL AT CORNISH, ME. — *Continued.*

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1864	3.25	1.75	5.87	5.30	2.20	0.80	0.60	8.30	3.70	3.80	6.50	4.70	46.77
1865	3.33	3.00	5.20	3.82	5.20	2.20	2.30	4.90	1.70	4.45	3.70	4.85	44.65
1866	1.45	5.70	5.30	1.60	3.10	4.20	3.54	5.06	5.18	2.84	3.30	3.73	45.00
1867	2.50	3.08	4.11	4.41	4.09	1.49	4.10	9.00	1.36	4.05	3.44	2.75	44.38
1868	4.11	1.16	2.25	2.59	9.15	3.11	2.09	2.12	8.79	1.20	6.55	2.52	45.64
1869	2.20	3.75	4.94	1.81	4.69	2.98	4.23	2.29	3.35	12.34	2.95	4.64	50.17
1870	5.31	3.30	5.15	6.88	1.55	3.97	2.71	3.55	1.31	4.35	5.12	2.63	45.83
1871	3.43	3.01	4.10	4.33	4.37	2.00	5.05	6.63	1.70	4.45	5.02	2.80	46.89
1872	1.95	1.70	3.05	1.08	2.66	5.37	4.12	5.86	2.71	2.80	4.75	4.11	40.16
1873	4.85	2.50	3.92	3.12	1.43	1.06	6.88	0.99	4.53	8.53	4.29	2.53	44.63
1874	4.21	4.43	1.52	3.40	3.61	4.04	5.10	4.23	2.14	1.53	2.08	1.95	38.24
1875	3.60	3.00	4.46	2.46	2.65	5.84	5.32	5.75	3.51	7.36	4.20	1.01	49.16
1876	2.64	4.26	7.82	2.76	2.84	3.80	4.44	0.16	4.28	2.09	3.21	3.21	41.51
1877	1.56	0.68	6.78	2.67	2.42	3.32	4.14	7.55	0.92	6.21	8.98	1.30	46.53
1878	2.74	2.45	2.59	4.75	1.05	4.92	2.47	4.02	3.15	5.24	5.58	9.04	48.00
1879	2.34	3.50	2.14	3.49	0.62	5.55	3.45	5.27	4.27	1.88	3.72	4.53	40.76
1880	3.43	3.08	1.82	2.88	1.37	1.46	2.45	3.13	3.37	4.52	3.08	2.86	33.45
1881	3.60	3.82	4.86	1.26	3.95	2.32	4.91	1.54	3.01	2.57	2.87	6.15	40.86
1882	4.15	5.02	3.66	1.67	3.85	3.86	4.34	1.99	7.74	1.64	1.20	2.90	42.02
1883	2.74	3.70	2.20	2.26	6.01	3.39	6.25	1.05	2.45	3.99	2.78	3.26	40.08
1884	2.82	7.13	5.31	4.36	5.45	1.88	6.37	4.56	1.39	3.71	3.90	5.42	52.30
1885	4.15	4.10	2.00	3.36	2.96	5.23	6.64	6.08	2.00	3.85	5.88	3.35	49.60
1886	7.17	5.80	2.65	3.08	3.66	2.19	3.80	5.08	4.89	5.10	5.48	4.56	53.46
1887	4.34	4.98	3.55	3.41	2.13	4.32	6.25	3.52	0.67	2.19	5.30	4.43	45.09
1888	4.45	4.98	5.66	2.75	4.10	1.61	1.74	4.48	7.97	6.67	6.63	2.80	53.84
1889	5.10	3.00	3.19	2.34	2.31	3.08	4.47	2.51	4.16	4.41	5.24	3.13	42.97
1890	3.45	4.43	5.24	2.26	5.58	5.76	4.12	9.08	6.14	2.66	2.79	4.03	55.54
1891	4.93	4.53	6.79	2.58	2.87	2.95	5.54	3.70	2.44	4.58	2.77	4.87	48.55
1892	5.09	2.45	1.85	1.14	5.44	5.59	2.64	11.12	2.76	2.11	6.18	1.38	47.78
1893	2.79	7.27	2.09	3.04	8.20	3.16	1.44	3.95	2.77	6.76	2.54	3.52	47.53
1894	2.35	2.51	2.01	3.27	7.44	2.49	4.70	4.74	5.31	5.22	2.73	3.00	45.77
1895	2.47	1.40	2.86	7.46	1.96	3.53	4.14	3.10	1.91	3.29	8.99	5.08	46.19
1896	1.50	9.49	10.98	1.15	3.64	2.68	3.45	5.02	7.04	5.51	4.89	1.71	57.06
1897	4.01	3.23	3.32	3.65	7.04	8.76	7.27	4.90	3.15	0.77	6.48	5.26	57.84
1898	5.48	4.76	1.38	4.53	3.54	3.28	1.46	3.17	3.69	5.20	5.48	2.55	44.52
1899	2.86	3.30	6.23	0.98	1.08	3.77	5.87	1.95	5.38	2.84	2.39	2.05	38.70
1900	6.94	10.26	10.80	2.17	3.34	2.45	2.38	3.65	2.98	4.96	7.79	3.39	61.11
1901	3.03	1.26	5.70	11.52	8.40	1.79	6.25	9.00	3.06	3.47	2.00	7.52	63.00
1902	4.18	2.61	8.10	6.56	3.05	4.92	3.24	8.36	6.68	6.80	1.70	7.06	63.26
1903	4.58	4.50	6.84	2.81	0.27	8.83	3.69	3.28	1.27	4.21	1.63	3.19	45.10
1904	3.39	2.14	3.95	7.67	5.71	2.94	2.24	5.12	5.10	1.41	1.24	1.66	42.57
1905	5.53	1.51	2.65	1.97	2.15	4.12	9.11	4.26	7.46	1.38	4.48	4.21	48.83
1906	2.93	1.76	3.67	1.91	5.14	7.95	5.02	1.92	0.90	4.32	2.57	4.15	42.24
1907	3.04	2.45	3.03	3.19	2.05	4.25	2.85	2.06	7.51	4.06	6.04	3.27	43.80
1908	2.85	4.67	1.90	2.95	5.47	0.65	2.66	2.62	1.54	3.41	1.47	3.63	33.82
1909	5.08	5.79	4.38	3.92	4.03	2.56	3.13	2.34	5.54	1.17	2.06	3.65	43.65
1910	4.25	5.19	1.76	4.90	1.68	3.39	1.64	3.53	3.40	2.04	2.62	3.42	37.82
1911	2.91	3.46	4.29	1.16	1.00	3.04	3.84	3.13	5.34	2.99	3.78	3.34	38.31
1912	3.32	2.17	5.75	2.63	5.30	0.77	4.06	3.54	2.66	3.62	3.82	4.09	41.73
1913	2.84	2.45	6.20	2.83	4.21	0.93	2.12	1.91	3.63	7.67	3.48	3.76	42.03
Av.	3.58	3.67	4.35	3.48	3.65	3.50	4.12	4.28	3.61	4.18	4.18	3.59	46.19

RAINFALL AT DANFORTH, ME. Elevation, 390 feet.

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1903	2.94	3.92	5.05	2.55	0.65	3.72	4.10	2.46	1.42	3.62	3.59	3.16	37.18
1904	2.95	2.89	3.48	2.86	4.31	1.76	2.56	3.02	6.23	2.66	2.35	1.51	36.58
1905	5.75	2.13	1.01	1.40	2.23	1.80	3.48	0.53	3.75	1.00	3.66	3.55	30.59
1906	3.95	2.22	4.94	4.88	2.40	2.57	2.21	2.79	1.41	4.73	5.56	3.32	40.98
1907	2.77	5.12	2.87	3.05	1.76	3.59	4.27	4.04	4.13	3.88	3.48	3.06	42.02
1908	2.91	5.02	2.32	2.60	4.11	1.60	2.93	4.10	1.28	6.81	1.49	2.57	37.71
1909	5.98	4.12	4.23	4.20	1.58	3.30	2.02	1.95	7.10	2.14	3.92	2.34	42.88
1910	2.91	2.48	0.35	1.85	2.40	3.57	3.55	1.93	1.80	1.62	3.28	1.35	27.09
Av.	3.77	3.52	3.03	2.92	2.43	2.74	3.14	2.60	3.39	3.31	3.42	2.61	36.88

RAINFALL AT EASTPORT, ME. Elevation, 53 feet.

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1833	3.60	1.00	2.50	4.30	4.70	4.60	3.70	6.65	1.40	5.20	2.80	2.55	43.00
1834	1.70	0.90	2.00	2.00	4.30	3.10	1.70	5.00	3.00	7.20	3.50	2.50	37.20
1871	2.00	1.52	1.32	2.38	2.58	2.16	2.88	5.68	2.96	5.96	2.14	1.96	33.54
1872	3.30	1.46	4.64	1.14	7.76	5.98	4.52	5.94	6.06	7.22	6.92	3.66	58.60
1873	3.84	2.82	3.20	4.40	2.42	3.13	4.46	2.40	4.37	7.38	5.32	1.36	45.10
1874	2.70	2.36	3.02	3.09	4.71	6.82	3.27	5.13	3.67	1.73	4.12	1.94	42.56
1875	0.89	3.93	1.39	1.80	2.90	5.86	6.61	4.29	5.21	7.50	3.93	1.11	45.42
1876	2.94	7.70	9.39	3.10	3.42	2.09	2.82	2.62	6.53	4.28	7.97	5.13	57.99
1877	3.42	1.31	8.83	5.47	2.60	2.19	3.36	5.85	1.73	4.67	8.20	2.96	50.62
1878	7.05	1.89	6.07	5.54	2.49	5.65	5.87	3.74	2.54	3.28	2.97	4.28	51.37
1879	1.65	3.39	3.77	3.95	3.18	3.42	5.57	3.66	3.42	3.28	4.52	3.67	43.48
1880	4.29	3.99	4.08	2.97	2.55	1.64	3.45	1.48	4.28	5.11	5.07	3.53	42.44
1881	1.64	4.11	6.78	1.66	13.22	4.47	3.73	3.64	2.80	4.31	3.37	6.25	55.98
1882	3.70	4.94	7.51	3.03	3.30	6.53	4.80	1.41	4.77	2.89	1.47	2.80	47.18
1883	3.20	3.63	3.61	2.25	6.60	5.23	9.07	0.49	2.49	8.41	3.76	4.43	53.17
1884	4.37	9.38	3.74	6.83	6.79	2.18	8.48	4.41	1.89	1.88	5.95	8.63	64.53
1885	3.86	2.95	5.94	5.35	4.79	4.64	1.99	4.26	3.64	5.96	4.78	5.90	54.06
1886	9.01	3.25	2.28	1.14	3.49	0.66	1.73	2.41	2.73	**5.80**	**5.76**	6.51	44.77
1887	7.78	3.74	4.46	2.92	2.57	6.01	4.51	3.56	1.05	2.45	2.32	5.59	46.96
1888	5.08	4.81	4.26	2.01	2.74	1.94	3.46	4.50	5.44	7.95	6.70	4.36	53.25
1889	3.44	4.13	4.06	3.19	2.20	2.85	3.69	2.00	2.52	5.02	4.60	4.56	42.26
1890	3.76	4.58	5.85	1.95	6.19	2.77	1.97	5.35	4.86	2.28	2.84	2.62	45.02
1891	5.50	3.13	2.75	1.37	1.64	3.00	2.61	4.06	2.65	4.43	2.31	2.99	36.44
1892	5.76	1.88	3.60	1.51	2.17	3.54	1.21	4.64	1.21	1.49	3.17	2.02	32.20
1893	2.08	3.26	1.35	1.94	1.91	1.85	2.61	4.04	1.93	1.83	0.99	6.08	29.87
1894	2.00	1.28	1.19	2.11	1.69	3.37	1.21	1.32	1.46	2.42	2.62	2.17	22.84
1895	2.70	1.93	2.90	2.29	1.29	1.46	3.17	4.83	2.00	1.15	6.41	2.75	32.88
1896	0.84	2.77	2.72	0.86	1.00	2.71	4.24	1.07	3.67	6.27	3.69	1.70	31.54
1897	3.14	1.45	4.03	3.35	7.88	3.32	2.78	2.79	1.82	0.61	5.79	2.61	39.57
1898	5.41	6.37	2.65	3.80	2.14	3.09	0.66	2.15	2.93	6.85	6.12	2.99	45.16
1899	3.86	3.35	5.48	0.89	3.92	2.58	4.78	0.53	2.03	1.92	3.68	3.42	36.44
1900	5.27	4.51	4.97	2.47	5.18	4.00	1.37	2.58	1.52	8.26	4.40	2.82	47.35
1901	4.80	1.65	4.88	5.58	3.29	5.45	0.91	2.48	2.92	1.72	1.91	6.02	41.61
1902	3.41	3.06	9.11	2.16	3.85	2.51	1.05	3.23	2.43	3.36	1.47	5.77	41.41
1903	3.85	4.01	4.98	3.33	2.52	1.69	3.85	1.14	1.62	2.83	3.59	3.26	36.67
1904	3.04	3.97	4.95	3.36	2.23	1.29	2.10	6.10	5.36	2.54	1.54	2.41	38.89
1905	4.14	2.77	1.10	0.83	2.64	3.03	2.62	1.76	4.32	0.47	4.29	3.91	31.88

RAINFALL AT EASTPORT, ME. — *Continued.*

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1906	3.36	2.30	6.32	3.51	5.63	1.46	2.01	1.79	0.78	3.61	3.56	5.13	39.49
1907	5.05	4.59	3.17	4.54	1.84	1.57	4.32	2.43	4.41	4.71	2.85	4.94	44.42
1908	4.17	3.71	3.96	2.64	2.58	1.01	1.95	3.32	1.60	4.09	1.52	5.01	35.56
1909	7.05	4.76	5.10	3.86	1.56	1.59	3.37	1.61	6.40	2.54	3.62	1.64	43.10
1910	3.80	4.52	1.98	3.42	1.55	2.72	1.92	1.44	1.84	1.85	2.14	3.68	30.86
1911	2.98	2.47	3.68	2.55	0.13	5.07	3.50	2.53	2.67	1.57	3.83	2.80	33.78
1912	4.37	2.16	3.76	3.06	3.93	1.35	2.25	3.76	1.67	3.05	2.86	5.83	38.05
1913	4.01	2.66	6.43	2.23	4.02	0.71	2.68	2.24	1.69	5.70	0.90	3.14	36.41
Av.	3.86	3.34	4.22	2.93	3.56	3.17	3.31	3.25	3.03	4.07	3.83	3.76	42.33

RAINFALL AT FAIRFIELD, ME. Elevation, 90 feet.

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1886	...	3.65	1.76	1.36	3.04	1.04	1.71	2.06	4.76	1.83	5.08	2.26	....
1887	2.39	2.62	2.05	3.64	0.41	2.84	8.77	2.98	1.11	1.93	3.48	3.44	35.66
1888	1.91	3.27	3.84	1.07	3.18	1.72	3.60	3.56	6.75	5.44	4.49	3.11	41.94
1889	2.91	2.12	3.09	1.06	2.54	4.25	3.11	1.74	1.95	3.57	5.13	4.26	35.73
1890	2.55	3.31	4.61	1.71	7.79	2.97	3.81	3.57	3.85	3.45	2.06	3.39	43.07
1891	6.12	2.23	4.75	1.97	2.26	2.03	4.63	4.00	2.06	1.38	2.14	4.56	38.13
1892	3.38	2.28	1.82	0.80	2.67	5.79	1.78	5.58	3.27	1.37	3.16	1.10	33.00
1893	1.62	2.77	2.49	2.13	3.42	0.99	2.27	2.90	2.12	4.89	0.86	2.36	28.82
1894	2.43	1.03	0.86	0.72	3.78	2.97	2.56	3.50	3.82	2.41	2.02	1.82	27.92
1895	2.23	0.34	1.58	3.50	1.83	1.96	3.08	2.59	1.11	1.58	5.47	3.77	29.04
1896	0.31	2.95	5.62	1.28	2.33	1.91	3.21	3.83	5.10	2.00	2.35	1.17	32.06
1897	3.31	1.00	2.63	2.40	4.47	3.39	3.52	2.82	2.54	0.53	3.98	3.06	33.65
1898	5.07	6.48	1.45	2.31	1.55	3.32	1.13	3.71	2.37	4.33	3.71	1.42	36.85
1899	2.76	2.73	3.66	1.05	2.05	1.39	5.13	0.46	3.58	1.11	2.32	1.93	28.17
1900	5.89	7.00	4.75	1.63	5.18	4.08	3.40	1.76	2.55	4.05	4.55	2.19	47.03
1901	2.74	1.95	5.22	3.96	2.35	1.64	2.99	3.39	3.79	2.77	2.19	7.98	40.97
1902	2.25	1.54	7.76	2.41	2.54	4.04	2.22	4.06	1.86	4.01	1.03	4.68	38.40
1903	3.94	3.39	6.35	1.95	0.37	3.56	**4.53**	**3.37**	**1.01**	**3.31**	1.06	2.70	35.54
1904	3.21	1.65	3.78	5.75	4.75	2.32	2.69	4.39	5.58	2.05	1.61	1.44	39.22
1905	3.78	0.99	0.88	2.15	2.22	3.49	3.65	1.43	2.45	0.38	3.80	3.19	28.41
1906	2.59	2.52	3.27	3.69	3.55	3.29	5.32	4.78	1.55	5.38	2.63	3.55	42.12
1907	3.19	2.65	1.43	3.49	2.62	2.95	5.36	1.32	5.23	2.34	3.66	2.68	36.92
1908	1.61	3.68	1.77	1.93	4.52	2.17	2.41	3.05	0.56	3.64	1.15	2.07	28.56
1909	5.91	3.94	2.73	3.05	2.43	2.34	1.77	1.17	5.16	1.14	3.19	1.48	34.31
1910	2.19	2.95	1.71	2.37	1.77	1.99	2.26	4.46	2.04	1.10	1.53	2.90	27.27
1911	1.98	2.19	4.03	0.58	1.34	2.21	2.75	2.38	2.28	1.68	2.81	3.12	27.35
1912	4.43	2.74	3.88	1.90	5.27	0.47	3.35	5.27	2.00	3.00	2.59	3.69	38.59
1913	2.47	2.92	3.29	**2.62**	2.53	0.21	1.51	2.50	2.81	5.18	0.65	3.01	29.70
Av.	3.08	2.71	3.31	2.26	2.95	2.60	3.36	3.13	2.91	2.74	2.73	2.97	34.75

RAINFALL AT FARMINGTON, ME. Elevation, 450 feet.

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1891	6.54	2.13	8.28	1.97	1.94	3.93	3.42	4.03	1.45	1.68	2.69	5.64	43.70
1892	5.45	2.33	2.33	0.85	3.75	6.26	3.29	5.09	4.16	1.49	4.44	1.39	40.83
1893	2.66	3.81	2.69	2.34	6.95	2.78	1.60	3.76	3.02	5.72	2.99	3.39	41.71
1894	1.64	2.22	1.52	1.43	5.14	3.20	1.92	2.61	5.73	5.02	2.97	2.76	36.16
1895	4.05	0.95	1.88	5.65	3.06	3.38	1.05	5.93	1.92	1.99	5.76	6.25	41.87

RAINFALL AT FARMINGTON, ME.—*Continued.*

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1896	0.80	5.58	10.83	2.66	2.96	2.49	3.75	3.97	4.62	3.88	4.22	1.15	46.91
1897	5.45	3.09	4.85	3.19	3.75	4.32	8.11	3.93	2.98	0.95	5.01	4.98	50.61
1898	5.18	6.85	0.55	2.71	1.79	4.34	2.80	3.27	2.82	4.63	4.40	1.44	40.78
1899	2.57	2.60	5.79	0.92	1.97	2.41	5.07	1.91	3.26	1.43	2.60	2.71	33.24
1900	6.19	10.76	7.04	1.74	5.12	5.51	4.88	2.30	4.82	4.23	8.50	1.77	62.86
1901	3.27	1.04	4.54	6.88	3.95	3.47	4.22	3.45	2.25	3.03	2.10	8.97	47.17
1902	3.06	2.32	8.43	3.67	5.16	5.28	1.93	3.34	3.60	4.68	1.19	4.31	46.97
1903	3.61	2.81	5.67	2.47	0.59	5.70	4.27	1.14	1.17	3.08	1.24	4.19	35.94
1904	3.52	0.72	3.13	6.36	5.72	1.03	4.97	4.58	4.44	2.09	1.83	1.76	40.15
1905	3.79	0.70	1.41	2.12	2.65	3.60	4.07	3.10	5.27	1.24	2.58	2.69	33.22
1906	2.29	1.89	4.30	2.06	3.67	5.41	6.38	2.42	0.65	4.84	2.94	3.17	40.02
1907	2.34	1.96	2.88	4.05	2.57	2.88	4.59	2.09	5.97	6.15	4.50	3.30	43.28
1908	2.84	4.44	2.82	2.38	5.88	2.05	2.82	4.87	1.48	2.59	1.63	3.10	36.90
1909	5.79	6.32	3.92	3.94	3.23	1.90	2.05	2.60	7.74	1.54	3.82	3.02	45.87
1910	3.48	2.97	1.41	4.38	2.16	3.15	3.10	3.94	2.30	1.19	2.31	2.74	33.13
1911	1.96	2.06	5.54	1.03	1.20	4.72	2.68	3.90	3.22	3.08	3.40	3.07	35.86
1912	4.24	2.79	3.81	2.91	6.52	1.03	2.03	5.80	3.53	4.61	4.62	2.65	44.54
1913	2.54	1.17	5.11	2.30	3.46	0.79	2.90	3.09	6.00	6.59	2.31	3.02	39.28
Av.	3.62	3.11	4.29	2.96	3.62	3.46	3.56	3.53	3.58	3.29	3.39	3.37	41.78

RAINFALL AT FORT PREBLE, ME. Elevation, 53 feet.

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1871	2.58	2.23	4.10	2.88	3.47	2.00	2.70	4.50	2.36	5.07	5.57	2.60	40.06
1872	1.69	1.20	2.10	1.32	2.74	4.88	2.58	8.20	2.46	2.94	4.81	3.91	38.83
1873	4.46	1.62	3.54	3.37	3.30	1.26	1.80	2.38	1.41	**6.15**	3.09	1.72	34.10
1874	2.80	2.52	1.10	3.38	4.00	1.82	4.47	3.14	3.29	0.80	3.17	**0.97**	31.46
1875	1.96	2.73	2.76	1.62	2.27	6.15	2.05	2.41	4.98	5.71	2.82	1.55	37.01
1876	2.68	5.58	4.76	1.18	2.36	1.44	3.65	0.24	5.16	1.98	2.89	1.82	33.74
1877	5.22	0.59	4.95	2.57	0.90	3.23	2.76	5.70	0.78	5.30	7.01	0.82	39.83
1878	4.32	3.84	2.15	5.62	0.48	3.72	0.78	2.88	1.30	3.56	4.82	3.74	37.21
1879	**2.30**	1.70	2.40	**3.68**	0.26	5.56	4.42	4.18	1.76	1.34	**4.90**	0.72	33.22
1880	0.66	2.26	1.18	2.14	1.20	3.84	1.92	2.04	2.18	4.36	4.08	1.52	27.38
Av.	2.87	2.43	2.90	2.77	2.10	3.39	2.71	3.57	2.57	3.72	4.31	1.94	35.28

RAINFALL AT GARDINER, ME. Elevation, 163 feet.

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1837	5.00	3.10	1.43	3.48	3.25	3.85	1.24	2.35	0.44	2.91	3.59	1.81	32.45
1838	1.62	2.09	1.43	1.76	3.29	4.61	1.10	2.02	4.24	3.97	3.38	0.68	30.19
1839	2.45	2.10	2.66	3.87	5.04	4.45	5.26	5.21	2.27	0.41	4.22	3.10	41.04
1840	1.77	2.29	4.14	4.14	4.22	4.20	1.72	3.72	1.54	6.02	3.88	3.52	41.16
1841	5.72	1.12	3.24	5.29	3.58	3.17	1.58	1.08	3.83	1.46	3.37	5.09	38.53
1842	2.88	4.49	3.26	2.51	1.83	3.05	3.08	2.35	3.06	1.61	3.33	5.67	37.12
1843	2.54	5.67	5.50	5.52	3.50	3.96	1.76	4.80	1.17	5.28	3.58	2.71	45.99
1844	3.95	1.68	4.82	0.65	3.01	1.79	1.47	3.03	2.36	5.72	3.93	5.91	38.32
1845	5.85	2.25	2.96	2.59	2.68	1.95	6.55	2.40	3.20	2.89	10.56	4.82	48.70
1846	2.66	1.29	6.27	1.59	4.83	2.77	2.62	3.83	1.00	2.09	3.42	2.95	35.32
1847	5.11	3.67	1.62	2.90	2.69	6.32	3.34	3.95	3.32	4.06	3.64	4.28	44.90
1848	3.84	2.53	2.84	1.22	8.64	1.88	6.29	4.32	5.76	4.59	2.38	4.56	48.85

RAINFALL AT GARDINER, ME. — *Continued.*

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1849	0.92	1.50	2.80	3.47	5.18	2.59	1.69	6.11	2.81	5.85	2.67	3.97	39.56
1850	3.09	2.96	2.29	2.98	11.76	5.44	3.04	4.31	3.70	5.29	2.41	4.10	51.37
1851	4.66	4.45	1.88	3.74	3.16	3.42	5.56	2.36	2.76	8.43	6.30	4.05	50.77
1852	2.36	3.89	2.22	6.13	0.36	3.89	2.80	5.87	3.51	4.38	6.33	4.92	46.66
1853	1.49	9.47	1.94	1.14	7.16	0.95	4.10	3.34	5.17	4.45	6.47	4.46	50.14
1854	2.78	4.35	4.73	5.62	5.28	5.05	4.95	1.41	5.03	3.25	8.12	3.16	53.73
1855	7.17	1.80	1.10	4.57	1.93	5.98	2.42	3.09	1.76	13.15	3.18	5.01	51.16
1856	2.25	1.95	0.90	2.46	4.52	2.06	2.49	7.49	3.82	3.20	2.14	4.70	37.98
1857	4.22	2.46	4.03	5.30	4.74	3.59	2.33	5.51	1.24	4.97	3.63	4.19	46.21
1858	3.11	2.33	3.16	4.44	3.02	2.51	6.43	7.26	3.74	5.06	2.91	2.87	46.84
1859	4.42	2.15	10.06	2.51	3.00	6.35	1.77	2.79	2.48	1.08	4.75	6.54	47.90
1860	1.04	3.30	2.14	1.32	0.87	2.36	1.97	4.70	3.63	3.81	5.36	3.26	33.76
1861	2.94	3.26	5.47	4.35	4.40	1.27	4.14	1.37	1.85	5.47	3.16	2.17	39.85
1862	4.20	3.60	3.49	2.75	1.92	3.81	2.41	1.94	3.18	5.21	4.33	2.56	39.40
1863	4.42	3.75	4.23	3.98	2.56	1.73	6.46	4.39	4.34	4.74	7.30	4.35	52.25
1864	3.51	2.07	4.58	2.46	3.94	0.90	0.59	6.12	4.32	2.76	5.77	4.03	41.05
1865	3.10	2.85	5.39	4.43	5.05	2.68	4.61	1.46	0.84	4.75	3.24	3.23	41.63
1866	1.63	5.24	5.47	1.91	4.97	3.50	3.01	5.50	5.66	2.59	3.18	3.00	45.66
1867	2.62	4.36	5.76	4.96	5.27	1.96	3.94	8.49	0.98	4.60	2.85	1.89	47.68
1868	2.86	1.87	2.38	2.28	9.59	3.20	1.87	1.06	8.24	0.98	6.76	2.04	43.13
1869	1.96	6.75	4.00	3.05	4.50	5.50	1.51	1.17	3.37	12.67	3.10	4.74	52.32
1870	6.12	5.93	3.22	4.78	1.90	1.94	2.43	1.99	1.33	6.39	4.19	2.82	43.04
1871	2.11	1.56	5.37	3.38	3.92	1.58	4.58	4.93	1.84	7.58	4.90	3.28	45.03
1872	1.86	1.84	3.03	1.85	2.58	3.88	3.10	6.98	4.73	3.42	5.82	3.57	42.66
1873	4.63	2.09	3.94	2.97	2.38	1.26	3.56	1.59	3.88	6.01	3.63	2.03	37.97
1874	4.39	3.33	1.96	4.63	3.14	3.86	5.57	6.21	2.76	1.72	2.99	1.54	42.10
1875	2.94	3.72	3.70	3.92	2.90	5.87	2.22	6.66	4.89	5.06	3.67	0.83	46.38
1876	3.03	5.88	7.96	2.69	3.62	2.95	6.16	0.20	4.63	2.59	4.13	3.45	47.29
1877	1.69	0.55	7.91	3.01	1.61	1.16	2.22	5.28	1.42	5.27	8.24	1.24	39.60
1878	3.57	2.73	3.13	5.84	1.49	3.69	1.08	4.43	2.39	7.82	4.60	7.55	48.32
1879	2.88	3.08	4.21	3.39	1.50	5.83	5.27	5.21	4.05	2.05	4.70	4.19	46.36
1880	4.10	3.61	2.68	3.29	2.39	1.53	3.94	2.18	4.06	4.39	4.86	2.96	39.99
1881	3.73	5.84	5.31	1.56	5.89	3.09	3.76	2.36	3.00	2.65	3.26	6.56	47.01
1882	3.56	4.96	5.04	2.65	4.74	4.25	2.60	0.34	7.00	2.02	1.14	3.53	41.83
1883	2.50	2.89	2.24	3.46	5.02	4.86	3.49	0.32	3.11	4.48	2.84	3.67	38.88
1884	5.40	7.29	5.40	6.53	4.00	1.22	5.17	4.22	2.11	3.14	3.29	5.05	52.82
1885	5.26	6.44	2.18	2.50	3.41	5.06	1.73	3.21	1.98	3.94	2.86	2.60	41.17
1886	6.61	7.25	3.90	1.43	3.76	1.84	1.94	2.82	3.68	3.67	5.97	4.68	47.55
1887	7.32	5.62	7.27	6.81	1.08	3.42	6.97	3.42	1.05	2.44	3.64	5.61	54.65
1888	5.03	5.90	5.09	2.27	2.48	2.59	2.20	4.33	7.12	6.71	5.98	4.20	53.90
1889	5.20	1.84	2.76	2.38	2.54	4.18	2.96	1.60	2.55	4.59	5.44	5.51	41.55
1890	3.18	3.78	4.52	1.51	7.84	3.61	**4.21**	**3.23**	**5.01**	**6.15**	**2.10**	**5.32**	50.46
1891	**7.91**	**4.10**	**6.26**	**2.39**	**3.04**	**3.21**	**5.03**	**2.06**	**1.47**	**2.81**	**2.52**	**4.72**	45.52
1892	**4.87**	**2.20**	**2.35**	**1.05**	**4.52**	**5.91**	**2.93**	**8.13**	**3.69**	**1.73**	4.52	1.12	43.02
1893	2.70	4.79	3.18	2.51	4.66	2.44	1.12	3.27	3.23	5.90	1.83	5.13	40.76
1894	3.30	1.99	1.39	1.86	5.84	1.18	2.30	3.08	3.81	4.25	2.21	2.80	34.01
1895	2.50	1.64	2.48	4.83	1.50	2.01	4.55	3.28	1.21	1.82	6.85	4.40	37.07
1896	0.87	5.25	7.19	2.02	2.80	1.94	3.18	2.88	7.60	2.64	4.12	1.52	42.01
1897	4.51	2.13	4.30	2.86	5.94	4.32	3.15	2.66	3.11	0.92	5.99	3.83	43.72
1898	5.54	5.45	1.76	3.44	1.60	3.56	0.98	3.73	2.90	6.23	4.57	2.74	42.50

RAINFALL AT GARDINER, ME. — *Continued.*

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1899	3.41	3.10	5.56	1.19	1.87	2.43	5.48	1.08	3.90	1.85	2.42	2.61	34.90
1900	7.19	8.96	7.23	2.50	5.12	1.34	1.87	2.77	2.45	1.47	5.28	1.64	51.12
1901	3.78	1.76	6.25	6.43	3.97	1.36	4.26	5.54	2.08	4.18	2.41	9.43	51.45
1902	2.67	1.70	10.33	3.71	2.01	1.52	2.07	4.16	3.22	4.90	1.21	5.35	46.15
1903	4.54	3.63	6.65	1.42	0.45	5.12	4.77	2.90	1.34	3.82	1.63	3.56	39.83
1904	4.12	2.24	3.71	7.10	3.95	1.29	1.25	4.53	5.09	2.02	2.39	2.28	39.97
1905	4.85	1.32	0.94	2.10	2.17	4.83	4.52	2.03	4.09	0.78	3.95	3.12	34.70
1906	2.95	1.98	4.86	3.74	4.52	4.89	6.40	1.21	0.94	5.73	3.95	3.41	44.58
1907	3.12	2.50	2.09	3.70	2.18	3.10	2.77	1.51	7.38	4.15	4.97	3.75	41.52
1908	2.65	4.58	2.17	2.20	4.29	1.03	4.38	2.36	0.92	4.16	1.40	3.28	33.42
1909	5.66	4.95	3.97	3.81	2.55	2.90	2.19	1.59	6.39	1.88	3.88	2.02	41.79
1910	3.22	4.30	1.98	4.45	2.03	2.26	1.83	4.53	2.58	2.26	2.70	2.97	35.11
1911	2.73	2.51	4.60	0.78	1.10	3.57	5.43	2.59	4.85	2.35	3.76	2.19	36.46
1912	4.89	2.40	5.41	3.36	6.11	1.03	2.38	2.99	3.42	4.17	4.64	3.65	44.45
1913	2.97	2.09	5.32	2.60	3.51	1.10	1.62	3.19	4.85	7.14	1.93	4.17	40.49
Av.	3.69	3.48	4.01	3.25	3.69	3.17	3.29	3.49	3.35	4.16	4.03	3.69	43.30

RAINFALL AT GREENVILLE, ME. Elevation, 1 000 feet.

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1905	...	...	...	1.91	3.22	3.99	2.52	1.43	2.82	0.86	2.51	1.22	....
1906	1.20	1.23	4.20	2.20	4.72	3.43	6.28	2.57	2.73	5.80	1.85	3.75	39.96
1907	0.98	1.30	2.56	3.78	2.54	6.90	5.81	2.68	5.64	4.63	4.76	3.12	44.70
1908	2.63	4.93	2.95	2.14	5.50	2.83	5.18	7.96	1.90	2.08	1.92	2.59	42.61
1909	4.51	4.80	4.76	4.22	2.72	3.60	3.34	3.00	10.12	1.73	4.57	2.59	49.96
1910	3.43	3.51	2.18	2.51	4.65	5.31	4.18	3.69	2.77	2.13	3.21	2.64	40.21
1911	2.91	2.68	4.95	1.24	0.40	3.85	4.01	4.06	3.89	2.63	3.86	4.27	38.78
1912	4.53	2.98	3.04	2.87	6.32	1.91	3.45	5.38	4.89	4.42	4.17	2.14	46.10
1913	2.15	1.52	5.29	2.54	3.01	1.82	5.01	2.80	4.30	7.64	2.98	4.10	43.16
Av.	2.79	2.87	3.74	2.69	3.73	3.71	4.66	4.02	4.53	3.88	3.41	3.15	43.18

RAINFALL AT HOULTON, ME. Elevation, 362 feet.

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1903	3.14	2.68	5.49	2.50	0.30	2.45	2.78	1.55	1.15	2.40	2.62	2.00	29.06
1904	4.60	2.35	2.60	2.80	3.65	2.52	2.58	3.00	6.70	3.40	2.20	1.44	37.84
1905	3.55	1.60	0.70	1.25	2.00	1.50	1.45	0.12	1.80	1.00	2.25	2.40	19.62
1906	2.70	2.10	3.20	3.20	2.00	1.40	2.55	1.50	1.20	7.34	1.20	2.48	30.87
1907	1.90	1.50	1.70	1.75	1.00	4.20	3.08	3.22	5.00	3.10	2.10	2.00	30.55
1908	1.89	4.75	2.51	2.25	2.20	2.00	1.30	3.57	0.49	1.35	1.07	1.59	24.88
1909	3.64	3.70	2.95	4.09	1.79	3.20	2.15	1.65	6.14	1.25	2.34	2.05	34.95
1910	0.95	2.00	1.40	2.66	3.75	2.50	2.17	1.07	0.85	1.65	1.42	0.87	21.29
1911	1.25	0.85	1.65	0.95	0.03	1.95	2.11	2.80	3.85	1.80	2.65	1.85	21.74
1912	1.60	2.10	3.21	1.95	3.20	3.20	3.45	8.40	1.50	4.36	0.95	2.30	36.22
1913	0.85	1.00	4.30	0.85	1.83	1.21	1.64	1.70	2.10	5.73	1.26	2.70	25.17
Av.	2.37	2.24	2.70	2.20	1.98	2.38	2.30	2.60	2.80	3.03	1.82	1.96	28.38

RAINFALL AT KINEO, ME. Elevation, 1 100 feet.

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1895	2.11	1.35	1.22	2.03	2.58	3.26	4.07	4.90	1.45	0.87	5.47	2.99	32.30
1896	0.37	2.51	4.49	2.24	2.46	2.47	4.02	2.00	3.27	3.61	1.95	0.90	30.29
1897	2.82	1.95	2.43	3.27	3.96	2.59	8.37	3.11	2.62	1.52	2.69	2.25	37.58
1898	4.24	6.90	0.82	2.22	...	...	0.90	3.30	4.50	...	...	...	....
1899	...	...	...	...	3.20	3.94	7.37	...	...	...	...	...	....
1900	5.17	3.47	3.90	...	3.49	3.24	5.21	1.51	2.55	...	...	...	....
1901	2.65	1.80	1.45	4.85	0.75	6.55	1.95	2.55	0.94	2.26	2.70	7.40	35.85
1902	2.15	3.60	4.73	2.65	4.67	6.15	4.03	3.01	5.46	...	0.81	2.01	....
1903	2.36	...	4.99	...	...	2.79	...	...	...	...	...	...	....
Av.	1.99	1.90	2.40	3.10	2.44	3.72	4.60	3.14	2.07	2.06	3.20	3.38	34.00

RAINFALL AT LEWISTON, ME. Elevation, 185 feet.

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1875	3.35	5.30	5.40	5.00	2.90	6.32	2.65	5.45	4.98	6.82	6.80	1.31	56.28
1876	4.25	5.80	12.31	3.49	3.85	4.15	6.03	0.85	5.91	1.90	4.18	4.50	57.22
1877	2.43	0.90	8.05	3.26	2.36	2.45	2.75	8.35	1.84	6.95	12.13	1.55	53.02
1878	4.47	2.20	3.80	5.78	1.42	6.26	2.25	3.66	4.39	8.12	5.49	10.77	58.61
1879	3.15	4.15	3.30	3.36	0.75	5.71	3.76	5.87	2.78	1.73	4.25	3.45	42.26
1880	3.72	3.40	2.20	2.55	1.79	1.54	2.93	2.02	4.28	4.60	4.68	3.10	36.81
1881	3.33	3.95	5.22	1.68	5.03	2.61	4.22	3.33	1.84	2.89	2.73	7.14	43.97
1882	3.76	5.81	4.41	2.34	5.15	3.19	2.69	0.99	7.38	1.32	1.65	2.93	41.62
1883	2.57	3.49	1.73	2.96	4.82	4.26	3.98	0.91	3.25	4.08	3.06	4.07	39.18
1884	4.89	6.87	5.40	5.97	4.36	1.49	5.66	3.18	1.36	2.43	3.65	5.54	50.80
1885	4.21	4.12	1.96	2.85	4.12	5.85	3.79	2.97	2.31	4.09	3.65	3.40	43.32
1886	6.59	7.45	2.56	1.71	3.23	1.26	2.16	3.09	3.09	4.80	4.80	5.05	45.79
1887	3.99	5.28	4.60	5.18	1.14	2.81	5.73	3.77	0.88	2.42	5.09	5.73	46.62
1888	5.98	5.09	5.11	2.87	3.48	3.34	3.62	4.13	7.73	6.04	5.77	3.25	56.41
1889	4.67	3.21	3.30	2.48	2.85	4.12	5.22	2.68	2.92	4.61	6.25	5.00	47.31
1890	3.00	4.14	5.88	2.17	7.51	3.71	4.83	3.47	5.13	5.47	1.89	5.55	52.75
1891	8.10	3.89	7.03	2.89	2.60	3.64	5.27	2.97	1.00	2.40	2.66	5.27	47.72
1892	5.52	2.21	2.43	1.05	4.62	7.22	3.18	8.11	4.48	1.81	4.54	1.49	46.66
1893	2.82	5.59	2.78	2.58	8.26	2.51	1.32	3.55	2.69	6.08	2.31	4.87	45.36
1894	2.93	2.26	1.99	2.44	6.55	1.74	1.46	2.55	4.48	5.62	2.59	2.98	37.59
1895	3.41	0.63	2.10	5.64	1.85	2.59	2.22	2.54	1.15	2.11	7.21	5.07	36.52
1896	1.04	5.82	10.10	1.63	2.37	2.58	3.08	2.98	6.73	3.58	3.79	1.45	45.15
1897	5.17	2.55	4.49	2.93	5.25	3.71	6.63	3.79	3.43	0.95	5.92	4.65	49.47
1898	5.93	7.07	1.40	3.48	2.03	4.85	2.35	2.21	3.04	4.34	4.44	2.85	43.99
1899	3.19	3.06	5.96	1.48	1.14	2.04	4.43	1.16	3.65	1.97	2.63	2.03	32.74
1900	6.85	8.69	8.01	1.92	4.04	1.69	2.02	3.69	2.48	4.42	4.95	2.13	50.89
1901	3.19	1.15	5.14	8.16	5.77	1.12	4.25	4.75	1.75	3.33	2.20	7.59	48.40
1902	3.04	3.01	8.96	4.37	2.67	5.21	2.02	3.52	3.70	5.07	1.45	5.26	48.28
1903	4.48	4.15	6.32	2.11	0.35	5.30	3.90	2.53	1.44	3.53	1.58	4.13	39.82
1904	4.26	2.32	3.71	6.74	4.34	2.64	2.39	4.29	3.82	1.88	2.63	1.93	40.95
1905	4.42	1.80	1.48	1.54	2.04	4.12	4.58	1.79	5.51	1.01	3.70	3.65	35.64
1906	3.15	1.59	4.51	2.93	4.21	7.42	5.44	0.80	0.85	4.97	3.26	3.94	43.07
1907	2.45	2.29	3.05	3.71	2.11	4.79	2.63	2.56	7.03	3.56	4.25	3.58	42.01
1908	2.82	4.68	2.18	2.64	4.94	0.90	3.66	2.73	0.80	5.01	1.61	4.16	36.13
1909	6.75	5.59	4.14	3.59	2.75	2.29	2.47	1.25	6.14	1.84	2.79	2.99	42.59
1910	3.44	4.24	1.90	4.16	1.94	2.62	2.40	4.81	2.68	1.69	2.18	3.14	35.20
1911	2.75	2.69	5.04	1.00	0.56	3.88	5.64	2.34	3.88	2.38	3.42	3.14	36.72
1912	4.45	2.83	5.26	2.86	5.00	0.79	3.03	2.96	3.45	3.47	4.24	3.82	42.16
1913	3.67	2.40	5.51	2.28	4.22	1.20	1.53	2.27	4.02	6.26	2.14	4.43	39.93
Av.	4.06	3.89	4.58	3.23	3.45	3.43	3.54	3.20	3.55	3.73	3.91	4.02	44.59

RAINFALL AT MADISON, ME. Elevation, 257 feet.

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1894	3.23	2.25	1.70	1.45	4.75	6.00	2.12	3.28	4.81	5.30	...	...	....
1902	3.91	3.88	11.04	3.62	5.49	7.45	2.29	5.93	3.70	6.61	1.42	4.63	59.97
1903	4.34	3.98	6.32	1.94	0.23	3.72	5.37	2.30	0.76	2.40	1.17	1.43	33.96
1904	2.28	1.71	2.79	7.63	6.63	3.36	6.10	7.38	6.34	2.98	1.23	1.55	49.98
1905	4.08	1.61	2.13	2.59	3.73	4.65	5.75	2.23	5.61	1.13	4.60	3.45	41.56
1906	4.04	2.99	4.83	4.27	5.12	5.72	4.58	2.02	1.09	6.14	3.02	5.21	49.03
1907	2.38	2.45	1.84	6.32	2.83	3.89	7.34	2.54	7.49	6.31	6.28	4.35	54.02
1908	2.75	4.52	2.48	2.56	6.59	1.63	3.91	5.18	1.40	3.51	1.53	2.47	38.53
1909	6.57	5.59	3.80	3.91	2.75	2.36	2.25	2 68	10.04	1.66	4.07	2.65	48.33
1910	4.13	2.69	1.91	4.38	2.71	3.57	4.01	3.69	2.95	1.51	2.87	2.99	37.41
1911	2.28	1.77	5.71	0.93	0.59	5.33	4.91	7.01	3.86	3.44	3.67	3.24	42.74
1912	5.27	3.15	4.82	3.45	6.26	1.38	2.83	6.96	3.73	5.90	5.17	3.25	52.17
1913	3.36	1.69	5.27	2.74	4.29	1.40	3.09	4.81	4.85	8.64	3.20	4.01	47.35
Av.	3.78	3.00	4.41	3.69	3.94	3.70	4.37	4.39	4.32	4.19	3.19	3.27	46.25

RAINFALL AT MAYFIELD, ME. Elevation, 1 000 feet.

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1885	...	...	...	...	...	9.03	2.91	3.70	2.79	3.50	3.40	3.09	....
1886	8.06	4.12	2.85	1.40	3.76	1.26	2.58	3.74	3.93	2.33	6.82	...	....
1887	...	...	...	5.91	2.08	4.01	6.53	3.35	1.41	2.74	4.27	...	....
1888	...	...	...	1.42	3.17	2.27	3.48	6.88	5.90	7.93	6.90	3.25	....
1889	...	...	...	2.09	3.66	5.70	4.98	3.35	6.52	5.83	5.39	...	....
1890	...	...	...	2.42	10.29	3.97	3.45	6.40	5.85	3.45	2.01	...	....
1891	...	...	...	3.75	2.37	3.34	5.11	4.78	1.58	1.56	2.91	...	....
1892	4.80	2.14	2.89	...	...	8.36	2.73	9.19	5.63	1.60	5.14	0.95	....
1893	2.47	1.83	2.36	1.86	5.65	2.69	3.27	5.20	4.21	7.37	3.49	3.02	43.42
1894	3.15	1.61	1.31	1.17	4.83	6.45	2.65	2.05	5.71	6.41	2.48	2.27	40.09
1895	2.31	1.08	1.25	6.21	3.83	3.03	4.44	3.86	2.09	2.25	7.63	5.84	43.82
1896	0.94	3.58	7.20	2.34	3.02	3.13	6.07	4.90	5.31	4.77	5.11	1.24	47.61
1897	3.99	2.07	3.92	4.56	5.04	3.41	8.04	4.07	3.01	1.43	5.12	3.43	48.09
1898	4.22	7.99	0.96	2.26	1.88	2.94	1.52	4.43	3.57	5.79	6.02	1.14	42.72
1899	2.50	4.00	4.87	0.99	3.02	2.04	4.79	1.05	3.33	1.71	2.19	3.05	33.54
1900	6.27	7.39	5.65	1.57	5.84	3.31	4.48	1.25	3.26	2.99	7.43	1.10	50.54
1901	2.60	1.20	5.55	6.33	2.26	2.94	5.40	5.25	2.63	3.43	2.44	8.63	48.66
1902	3.21	3.60	9.50	4.16	3.40	7.39	2.95	6.36	4.33	5.83	1.65	4.12	56.50
1903	5.48	3.27	5.33	1.56	0.58	6.54	5.27	3.03	0.85	3.12	1.61	3.06	39.70
1904	3.07	1.81	2.76	3.42	6.86	3.17	4.41	5.32	5.73	2.42	1.58	1.47	42.02
1905	4.25	1.11	1.00	2.17	3.29	3.39	4.39	1.86	4.40	0.96	2.87	2.69	32.38
1906	2.69	2.01	5.24	2.70	3.90	4.61	4.66	4.13	2.23	5.54	3.61	3.38	44.70
1907	1.40	1.72	1.86	4.04	2.40	4.64	4.75	3 18	5.67	6.11	5.35	5.42	46.54
1908	3.64	...	...	...	...	...	...	...	...	...	...	...	....
Av.	3.24	2.95	3.92	3.02	3.72	3.98	4.47	3.73	3.76	4.01	3.90	3.32	44.02

RAINFALL AT MILLINOCKET, ME. Elevation, 386 feet.

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1900	6.45	9.41	6.24	1.63	6.41	3.96	6.53	1.73	2.02	6.11	3.77	0.91	55.17
1901	2.53	0.59	5.12	5.63	0.95	3.03	1.78	4.59	1.85	3.68	2.55	8.75	41.05
1902	3.97	0.86	6.47	1.95	2.47	5.82	2.50	3.63	4.15	5.09	1.88	5.23	44.02
1903	3.34	3.30	6.39	1.96	0.72	2.07	4.25	2.48	2.82	2.72	2.64	3.64	36.33
1904	3.35	1.89	3.86	2.82	4.38	2.16	4.96	4.06	6.46	3.21	2.20	1.89	41.24
1905	5.45	1.25	0.77	2.05	2.91	2.41	2.92	2.08	3.47	1.49	4.29	3.57	32.66
1906	3.09	3.45	6.29	3.69	3.57	2.96	3.24	1.90	3.16	7.10	4.21	3.35	46.01
1907	3.24	1.95	2.16	3.60	2.50	7.33	4.70	4.04	5.31	4.14	3.75	3.32	46.04
1908	2.52	3.82	2.65	1.93	5.16	2.10	2.35	5.01	2.46	3.30	1.88	3.32	36.50
1909	5.24	5.36	4.24	4.64	3.05	2.91	3.09	3.07	9.70	1.80	4.92	2.07	50.09
1910	4.05	3.56	1.66	4.27	2.97	4.37	3.72	2.39	2.61	2.21	2.86	2.96	37.63
1911	2.87	1.96	4.26	1.08	0.51	5.06	4.56	3.90	2.73	1.77	4.36	4.29	37.35
1912	2.36	3.69	1.98	2.34	7.12	2.49	2.27	6.94	3.55	6.75	6.34	2.74	48.57
1913	3.40	2.65	4.84	1.67	2.87	1.04	3.49	3.24	3.79	6.77	1.62	4.03	39.41
Av.	3.70	3.12	4.07	2.80	3.26	3.41	3.60	3.50	3.86	4.01	3.38	3.58	42.29

RAINFALL AT ORONO, ME. Elevation, 129 feet.

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1869	2.54	4.26	3.36	2.39	2.95	...	1.62	1.91	3.67	9.57	3.36	...	...
1870	5.61	4.30	2.11	3.55	1.96	2.07	1.78	3.21	2.23	5.53	5.61	3.04	41.00
1871	2.60	2.53	4.11	3.91	3.48	2.58	2.13	3.85	1.10	7.50	3.58	4.16	41.53
1872	2.18	1.70	5.23	1.93	3.92	4.47	2.68	6.23	3.55	6.01	7.06	3.66	48.62
1873	4.09	2.97	4.70	2.59	1.96	1.32	3.26	1.81	4.74	6.56	5.05	1.74	40.79
1874	4.57	5.50	3.40	3.76	4.74	4.93	2.10	5.39	4.37	1.14	3.06	1.98	44.94
1875	2.00	3.80	4.45	3.85	3.31	4.85	2.11	2.32	5.10	4.75	3.87	1.51	41.92
1876	3.92	8.39	8.20	1.65	3.73	2.56	5.80	0.91	4.28	3.91	4.35	4.67	52.37
1877	3.29	1.20	5.67	3.18	1.94	1.98	1.64	5.28	1.11	4.78	7.95	2.15	40.17
1878	5.08	2.41	2.73	3.46	2.14	5.42	4.77	3.00	2.00	4.73	4.91	7.92	48.57
1879	3.28	3.56	3.40	3.51	1.80	4.73	5.79	5.66	4.93	3.49	2.98	3.60	46.73
1880	2.83	2.83	2.86	4.15	2.17	0.73	3.32	1.54	3.84	4.15	3.52	1.90	33.84
1881	2.08	3.35	3.64	1.28	4.85	3.38	2.72	5.89	2.35	3.57	2.81	6.88	42.80
1882	4.19	3.96	5.20	2.05	4.52	4.44	3.10	1.64	6.44	1.09	1.78	2.85	41.26
1883	2.44	2.34	1.89	3.80	5.10	3.66	6.90	0.53	2.23	4.97	3.75	2.99	40.60
1884	4.44	6.85	4.37	3.38	5.42	1.37	2.38	3.12	2.19	2.70	3.99	4.74	44.95
1885	4.73	4.45	2.78	2.34	3.38	4.60	4.70	7.36	2.52	5.12	5.37	5.64	52.99
1886	6.64	5.42	2.87	1.80	4.67	2.74	1.05	2.27	4.11	1.42	8.67	6.38	48.04
1887	7.56	5.89	5.88	5.08	1.25	3.36	7.11	4.60	0.95	3.00	3.48	4.72	52.88
1888	4.97	6.11	6.48	1.78	2.82	3.65	2.47	4.59	6.97	7.51	6.43	4.96	58.74
1889	5.37	5.20	4.62	1.93	1.86	4.93	3.23	1.65	2.21	4.04	4.50	3.40	42.94
1890	3.33	4.52	5.81	2.02	10.52	3.84	3.84	4.55	4.47	3.36	2.67	4.10	53.03
1891	7.66	2.93	5.20	3.26	2.83	3.20	3.56	4.67	3.68	2.85	2.78	4.76	47.38
1892	**4.93**	**2.26**	**2.73**	**1.08**	**2.52**	**4.61**	**1.54**	6.41	3.91	1.75	4.47	2.26	38.47
1893	0.85	5.75	1.45	2.18	2.55	2.69	3.25	3.90	6.02	3.34	1.43	4.21	37.62
1894	3.01	1.73	1.23	1.18	3.84	2.90	2.41	2.01	3.40	4.33	**2.39**	1.75	30.18
1895	**3.82**	0.83	2.39	3.81	2.13	1.35	2.85	2.14	1.05	1.51	3.61	**3.72**	29.21
1896	**0.71**	2.20	6.95	**1.11**	**2.12**	**2.28**	2.58	4.26	8.00	3.75	4.23	1.30	39.49
1897	3.03	2.38	3.96	3.03	4.49	3.71	2.02	5.09	2.65	1.01	5.04	3.58	39.99
1898	6.32	8.05	2.23	4.95	1.02	5.28	2.44	3.14	2.29	6.19	6.84	1.27	50.02

RAINFALL AT ORONO, ME. — *Continued.*

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1899	2.75	2.27	4.76	0.66	4.12	4.10	4.49	T	3.20	2.92	2.01	3.09	34.37
1900	8.14	6.75	5.47	2.01	8.24	3.83	2.53	1.58	2.94	5.70	4.59	2.02	53.80
1901	4.33	1.95	5.45	5.12	2.07	1.79	2.75	3.76	4.22	4.12	2.54	7.94	46.04
1902	3.65	1.80	8.89	2.94	2.77	6.03	1.81	4.96	1.94	5.04	1.76	4.77	46.36
1903	3.62	3.48	6.22	1.71	0.73	2.09	6.49	2.22	1.21	3.44	2.79	3.14	37.14
1904	3.63	2.57	3.18	2.31	4.26	2.17	2.43	4.46	6.47	3.10	1.62	2.00	38.20
1905	4.28	2.20	0.83	2.22	3.47	3.13	2.19	2.13	3.19	0.78	4.08	3.51	32.01
1906	3.11	2.27	4.34	3.65	5.44	2.86	2.47	1.69	1.51	4.90	3.52	3.37	39.13
1907	4.01	3.01	2.25	3.53	1.77	5.77	3.44	1.41	6.12	2.71	4.22	3.84	42.08
1908	3.36	4.23	2.90	2.37	4.59	1.35	2.85	4.69	0.81	6.03	1.39	2.94	37.51
1909	5.87	5.32	5.23	4.42	2.21	2.11	2.37	1.82	9.09	2.43	4.14	1.98	46.99
1910	3.57	3.42	1.91	2.76	1.42	2.70	2.43	3.72	2.79	2.56	1.52	2.88	31.68
1911	3.21	2.78	3.97	1.18	0.75	4.60	4.45	2.94	3.05	1.94	3.28	3.91	36.06
1912	2.87	2.50	3.93	4.60	8.05	2.32	4.60	4.69	3.11	4.97	2.92	3.27	47.83
1913	2.80	2.06	4.42	3.57	3.15	1.38	5.86	3.15	4.42	7.35	3.39	2.87	44.42
Av.	3.97	3.64	4.10	2.83	3.41	3.27	3.29	3.41	3.56	3.91	3.86	3.58	42.83

RAINFALL AT OXFORD, ME. Elevation, 350 feet.

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1868	2.00	1.30	1.80	...	...	...	...	...	...	...	...	2.06	....
1869	**2.06**	5.75	2.97	3.75	4.75	4.47	2.10	0.57	4.40	15.10	4.45	4.25	54.62
1870	5.50	6.59	4.60	4.75	1.40	1.50	1.60	1.65	1.23	3.25	3.40	1.85	37.32
1871	2.40	2.10	5.00	4.20	4.70	1.85	5.25	5.50	1.55	5.80	5.40	3.39	47.14
1872	1.38	2.50	2.10	0.80	3.55	5.28	2.90	7.50	3.35	**3.09**	5.40	2.52	40.37
1873	4.20	2.41	4.59	2.96	2.05	0.80	3.55	1.55	3.78	10.13	3.05	2.05	41.12
1874	3.30	2.74	3.25	4.16	3.70	3.35	4.48	5.25	2.35	1.93	1.70	1.70	37.91
1875	3.31	3.45	4.24	...	...	...	...	...	...	...	...	...	....
Av.	3.14	3.68	3.75	3.44	3.36	2.87	3.31	3.67	2.78	6.55	3.90	2.63	43.08

RAINFALL AT PATTEN, ME. Elevation, 550 feet.

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1902	...	...	...	1.00	3.52	6.20	3.00	3.80	4.30	4.80	...	2.20	....
1903	1.60	**2.84**	3.02	**2.03**	0.12	2.29	4.03	2.64	0.69	2.58	2.42	3.40	27.66
1904	2.90	0.60	1.02	2.90	4.25	4.15	4.30	2.49	10.42	3.10	1.82	1.50	39.45
1905	4.20	0.90	0.90	2.50	2.15	5.25	2.00	0.06	3.96	1.38	3.30	2.00	28.60
1906	3.50	3.80	5.90	2.40	1.30	1.84	5.26	1.57	1.52	10.10	1.88	2.73	41.80
1907	1.00	2.40	1.40	1.50	2.05	10.04	4.21	5.00	6.04	5.70	5.30	4.00	48.64
1908	**2.52**	**3.82**	**2.65**	**1.93**	**5.16**	**2.10**	1.51	5.00	0.30	**3.30**	**1.88**	1.55	31.72
1909	5.80	4.75	4.16	5.14	1.79	2.50	6.42	3.91	9.71	2.38	4.19	1.95	52.70
1910	3.10	3.34	0.93	5.35	6.68	4.28	4.27	2.28	4.63	2.98	2.36	2.73	42.93
1911	3.13	1.47	3.65	1.02	2.58	4.46	3.73	4.55	6.75	1.54	4.02	3.10	40.00
1912	**2.36**	**3.69**	1.47	**2.34**	**7.12**	**2.49**	3.02	11.28	4.00	5.60	4.51	1.21	49.09
1913	3.40	2.60	3.14	**1.67**	3.64	1.64	4.00	4.29	1.65	7.18	0.20	2.14	35.55
Av.	3.04	2.75	2.57	2.62	3.35	3.73	3.89	3.91	4.51	4.17	2.90	2.39	39.83

RAINFALL AT PORTLAND, ME. Elevation, 99 feet.

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1871	2.58	2.23	1.69	3.41	3.71	2.20	2.80	5.88	2.08	6.55	6.37	3.00	42.50
1872	0.77	0.35	1.44	1.60	3.23	5.95	3.23	6.97	3.12	3.55	4.27	2.54	37.02
1873	4.42	0.93	2.87	2.79	2.80	1.60	3.52	2.63	4.03	6.15	3.36	1.80	36.90
1874	3.13	2.13	1.14	4.03	3.86	3.14	5.41	5.29	2.73	1.23	3.18	0.97	36.24
1875	2.58	2.85	3.63	3.16	2.62	5.51	1.81	2.70	3.49	3.53	2.64	1.62	36.14
1876	2.38	3.84	5.29	2.59	4.68	2.55	6.00	0.54	4.29	1.57	2.83	2.48	39.04
1877	2.65	0.60	5.91	2.26	2.24	3.43	2.81	7.90	1.11	5.56	7.84	1.20	43.51
1878	3.83	3.28	2.19	5.60	1.16	3.13	1.56	2.93	1.34	4.48	3.74	5.36	38.60
1879	2.30	3.80	4.42	3.68	0.88	6.61	3.80	3.73	2.67	1.43	4.90	3.39	41.61
1880	5.36	4.50	1.42	2.66	1.35	3.03	3.12	2.32	3.20	4.21	3.25	3.17	37.59
1881	4.30	5.30	5.09	1.43	5.64	3.99	3.94	1.42	2.75	2.90	3 13	6.79	46.68
1882	4.39	4.58	3.97	1.97	3.95	3.20	2.00	0.66	7.58	2.90	0.93	2 61	38.74
1883	2.53	2.81	1.58	1.33	2.91	2.94	5.05	0.36	2.68	3.51	3.66	2.63	31.99
1884	4.54	6.92	4.86	6.12	6.46	1.41	6.78	3.98	0.56	2.21	2.25	6.42	52.51
1885	3.02	3.68	1.59	2.09	1.91	4.06	5.63	5.91	1.37	4.32	3.43	2.94	39.95
1886	4.65	5.52	3.26	2.28	4.07	1.66	3.63	3.93	5.56	6.70	5.33	5.04	51.63
1887	3.89	5.73	4.15	4.96	1.93	4.07	4.70	6.56	0.70	2.47	4.74	5.17	49.07
1888	6.05	5.40	3.72	3.80	3.36	2.79	1.90	4.36	8.22	7.47	7.46	4.71	59.24
1889	3.47	2.74	2.68	2.39	2.65	3.26	3.10	2.76	2.49	3.47	7.95	4.96	41.92
1890	2.89	4.04	6.24	2.51	6.10	4.53	3.58	2.99	4.88	6.82	2.31	5.08	51.97
1891	7.72	4.31	5.48	1.89	3.47	2.77	4.78	1.15	1.94	3.22	2.38	4.17	43.28
1892	4.22	2.18	2.27	1.04	4.41	4.60	2.68	8.14	2.89	1.64	3.76	1.32	39.15
1893	2.19	4.51	3.58	3.71	7.59	3.62	0.96	2.74	2.33	5.13	1.83	5.42	43.61
1894	3.13	2.70	1.97	2.55	7.33	2.01	2.96	3.27	2.76	4.65	2.05	1.75	37.13
1895	2.47	0.94	3.37	5.95	1.59	1.97	3.59	4.72	1.79	1.91	7.18	3.30	38.78
1896	2.00	5.27	8.02	1.65	3.21	2.23	3.10	2.57	9.57	3.19	2.45	2.18	45.44
1897	4.09	2.60	4.55	2 60	5.87	4.97	2.62	1.41	2.34	0.46	6.69	4.22	42.42
1898	6.61	7.61	1.21	4.33	2.62	3.98	1.78	3.88	3.48	5.90	5.51	2.85	49.76
1899	3.39	3.41	6.49	1.55	0.73	1.04	3.92	1.66	4.47	1.46	3.11	2.84	34.07
1900	6.28	9 25	6.00	2.25	4.09	1.25	1.70	3.72	2.56	5.81	5.50	2.38	50.79
1901	3.34	1.68	6.43	7.47	7.17	0.93	4.21	3.26	2.18	3.12	1.89	7.14	48.82
1902	2.73	3.34	8.76	3.97	2.17	3.78	2.21	4 36	4.08	4.95	0.86	6.54	47.75
1903	4.90	3.44	5 60	2.51	0.68	5.53	2.50	1.85	2.06	3.57	1.44	3.46	37.54
1904	4.04	2.35	2.52	7.51	4.75	2.45	1 63	3.64	3.49	1.16	1.93	1.43	36.90
1905	5.16	1.78	1.97	1.43	2.58	3.08	3.65	2.78	5.35	0.95	4.45	5.44	38.62
1906	2.87	2.00	4.95	3.53	4.79	7.18	4.32	1.73	0.58	2.75	3.04	4.80	42.54
1907	2.46	2.95	2.58	2.75	1.99	3.55	3.63	2.07	7.81	2.53	4.40	4.12	40.84
1908	2.42	3.72	2.26	2.14	4.76	0.53	2.58	3.73	0.69	3.65	1.34	2.92	30.74
1909	4.71	5.07	2.76	3.13	2.95	2.33	2.14	1.68	4.68	1.50	2.83	2.06	35.84
1910	2.90	4.84	1.62	4.12	1.65	3 26	1.64	2.79	2.89	1.27	1.85	3.43	32.26
1911	2.58	5.02	5.60	2.25	1.37	2.74	4.71	2.56	2.84	1.85	3.51	4.49	39 52
1912	4.86	4.44	6.34	3.49	3.81	0.55	2.50	2.26	2.91	2.29	3.58	4.16	41.19
1913	2.47	2.70	5.35	2.02	2.92	0.59	2.27	2.99	3.46	5.72	1.20	4.29	35.98
Av.	3.66	3.66	3.88	3.13	3.44	3.12	3.27	3.32	3.30	3.48	3.63	3.64	41.53

RAINFALL AT RUMFORD FALLS, ME. Elevation, 505 feet.

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1894	2.40	1.85	1.57	1.20	5.55	3.20	5.15	4.20	4.35	3.95	4.25	2.70	40.37
1895	3.50	0.60	1.06	5.60	4.40	2.30	2.15	3.10	2.05	1.60	5.40	5.71	37.47
1896	1.10	6.65	10.00	1.65	2.75	1.75	2.90	3.45	4.40	3.20	3.70	0.95	42.50
1897	3.90	3.15	4.05	3.68	4.24	5.85	9.34	2.68	1.97	0.66	5.63	3.73	48.88
1898	5.57	8.49	1.08	2.87	2.65	5.20	2.85	4.99	3.96	4.52	5.00	2.15	49.33
1899	2.38	4.26	5.89	1.50	1.15	2.56	4.71	0.64	3.00	2.05	1.94	1.95	32.03
1900	5.80	7.96	5.82	1.21	4.57	3.35	4.35	2.42	2.31	3.91	7.22	1.15	50.07
1901	2.77	0.74	4.05	7.91	6.54	3.84	4.91	3.47	2.59	3.48	1.76	5.53	47.59
1902	1.76	2.19	3.12	3.31	5.32	4.45	2.31	3.86	3.88	4.14	1.47	4.60	40.41
1903	3.51	3.89	4.09	1.51	0.18	5.25	6.01	2.96	1.21	2.69	0.98	3.63	35.91
1904	2.88	1.41	2.51	5.72	3.89	2.42	2.34	4.10	4.75	2.76	1.43	1.51	35.72
1905	3.90	1.11	2.08	2.11	2.33	4.15	4.61	2.85	4.21	1.51	2.92	2.98	34.76
1906	2.01	1.68	2.79	1.69	4.22	5.07	6.83	3.47	1.01	4.79	2.68	3.39	39.63
1907	1.67	1.52	2.90	3.88	1.84	3.03	3.53	1.22	6.34	5.17	5.14	2.86	39.10
1908	2.84	4.08	1.95	1.73	5.90	1.42	2.30	3.62	1.26	1.96	1.48	2.38	30.92
1909	5.39	6.12	4.04	3.49	3.51	2.11	2.34	1.79	7.08	1.03	3.31	2.13	42.34
1910	3.88	2.68	1.78	4.68	2.83	2.97	2.22	3.51	2.94	1.36	2.28	2.31	33.44
1911	1.97	2.58	4.16	0.76	0.88	2.75	2.46	4.85	3.20	3.23	2.88	2.74	32.46
1912	2.88	2.70	3.19	2.44	5.51	1.10	2.22	4.89	3.88	4.28	3.70	2.54	39.33
1913	2.38	1.48	5.01	2.91	3.68	1.08	2.65	2.46	4.12	6.86	2.69	2.65	37.97
Av.	3.12	3.26	3.56	2.99	3.60	3.19	3.81	3.23	3.42	3.16	3.29	2.88	39.51

RAINFALL AT SONGO, ME. Elevation, 280 feet.

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1900	...	...	...	1.56	4.37	1.52	1.75	2.21	2.59	3.22	5.35	1.82	...
1901	2.51	0.82	3.82	8.05	7.12	1.65	4.11	5.35	2.04	3.30	2.04	7.44	48.25
1902	3.23	3.80	6.22	4.71	3.02	5.50	2.47	5.05	3.31	6.41	1.22	4.29	49.23
1903	4.23	4.11	6.34	1.86	0.47	5.97	4.27	3.09	1.06	3.41	1.65	3.87	40.33
1904	3.40	1.82	3.42	5.84	4.63	1.70	1.81	4.27	4.38	1.31	1.85	1.52	35.95
1905	4.64	1.11	2.29	1.49	1.85	3.84	5.36	2.05	5.91	1.13	3.24	3.43	36.34
1906	2.89	1.16	3.45	2.37	5.58	5.54	3.99	0.95	0.67	4.16	2.41	4.04	37.21
1907	1.74	2.25	2.83	3.15	1.98	2.99	2.23	1.91	6.52	3.67	4.54	2.86	36.67
1908	2.78	4.22	2.20	2.34	5.34	0.76	2.90	3.36	0.48	3.43	1.26	3.23	32.30
1909	5.63	4.87	3.95	4.18	3.23	2.20	2.62	2.17	4.83	1.78	2.53	3.02	41.01
1910	3.10	4.40	1.23	4.37	1.88	3.63	1.95	4.84	2.83	3.25	2.31	3.54	37.33
Av.	3.42	2.86	3.58	3.84	3.51	3.38	3.17	3.30	3.20	3.18	2.30	3.72	39.46

RAINFALL AT THE FORKS, ME. Elevation, 580 feet.

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1902	3.50	3.35	5.29	3.20	4.62	6.42	2.92	3.43	5.39	3.40	2.30	3.10	46.92
1903	2.30	3.63	4.42	1.35	0.61	4.36	4.58	3.24	0.91	1.60	1.73	2.97	31.70
1904	2.95	1.40	1.95	3.70	5.08	4.64	7.53	2.69	6.82	2.23	1.34	1.58	41.91
1905	3.39	1.11	1.30	1.68	3.58	4.33	3.37	1.86	3.47	1.24	2.90	2.40	30.63
1906	2.24	2.05	4.20	2.18	3.13	3.07	4.56	2.57	3.79	5.98	2.61	2.82	39.20
1907	1.78	2.15	2.96	5.23	2.42	4.21	8.08	2.62	5.75	4.63	4.76	2.02	46.61
1908	2.02	3.74	2.10	2.22	4.42	2.80	4.61	3.01	1.00	2.28	2.22	2.60	33.02
1909	4.36	4.04	3.85	4.65	3.14	2.22	3.50	3.35	7.56	3.05	4.34	2.05	46.11
Av.	2.82	2.68	3.26	3.03	3.37	4.01	4.89	2.85	4.34	3.05	2.77	2.44	39.51

RAINFALL AT VAN BUREN, ME. Elevation, 510 feet.

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1902	...	...	...	2.17	4.42	6.54	3.48	2.69	5.64	5.51	2.24	2.75	....
1903	2.70	3.81	4.65	2.25	1.56	2.03	4.71	3.05	1.12	2.57	2.05	2.51	33.01
1904	2.76	2.19	3.28	2.21	5.04	2.74	4.85	2.16	5.10	2.86	0.64	1.43	35.26
1905	1.42	1.61	0.78	1.08	3.26	3.27	2.54	0.15	2.20	1.14	1.60	2.60	21.65
1906	1.40	1.45	2.80	1.60	1.90	4.50	2.50	6.00	3.50	6.30	2.10	3.80	37.85
1907	2.80	1.80	3.20	2.30	0.90	6.20	5.90	4.40	3.70	2.87	3.00	4.70	41.77
1908	2.55	4.90	2.10	2.00	5.10	2.80	1.80	5.45	0.75	3.60	1.94	1.00	33.99
1909	2.80	2.60	1.00	3.00	1.00	3.30	5.60	9.10	...	...	...	...	....
1913	2.83	1.98	2.72	1.42	3.86	2.37	3.53	2.71	2.72	3.14	0.62	3.87	31.77
Av.	2.35	2.53	2.79	1.84	3.09	3.41	3.69	3.42	2.73	3.21	1.71	2.84	33.61

RAINFALL AT UPPER DAM, OXFORD COUNTY, ME. Elevation, 1 470 feet.

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1886	4.29	2.32	2.74	1.17	3.20	3.15	2.01	4.13	4.71	1.56	4.27	2.63	36.18
1887	3.92	3.37	1.96	3.53	2.01	4.46	5.43	3.33	1.26	1.96	3.10	3.67	38.00
1888	2.40	1.73	3.09	2.04	2.89	2.96	2.28	4.79	4.27	6.62	6.50	2.13	41.70
1889	2.48	0.77	2.68	0.63	3.79	3.23	3.17	2.50	5.30	3.62	0.86	1.67	30.70
1890	3.26	1.45	2.40	1.37	4.00	3.69	2.45	4.23	5.83	2.90	2.73	2.59	36.90
1891	3.80	3.26	6.36	1.76	2.65	1.49	3.02	3.47	1.35	1.85	2.51	5.67	37.19
1892	4.57	0.67	4.74	1.39	1.48	4.68	4.80	6.68	1.99	0.10	6.47	0.80	38.37
1893	1.35	3.06	1.24	2.80	3.78	4.10	2.95	3.08	3.14	2.97	1.46	3.07	33.00
1894	3.76	1.49	0.24	1.48	3.19	2.61	4.17	2.68	3.52	2.56	1.70	1.57	28.97
1895	3.77	0.29	1.18	2.92	4.64	2.48	1.57	3.16	2.21	0.40	6.41	3.89	32.92
1896	0.50	2.27	5.13	3.57	2.40	3.15	4.59	3.20	4.97	1.33	1.82	2.20	35.13
1897	2.27	1.81	5.07	3.14	4.92	4.95	7.28	1.31	2.88	1.00	2.83	2.28	39.74
1898	3.08	5.63	0.74	1.15	2.38	5.98	2.98	4.24	3.55	3.90	2.46	1.35	37.44
1899	1.87	2.82	3.32	0.00	2.45	2.40	3.16	0.51	1.97	1.70	1.83	1.69	23.72
1900	3.22	4.21	3.60	0.32	5.47	3.59	5.12	2.16	2.54	2.43	5.86	1.00	39.52
1901	3.95	0.55	2.69	3.22	3.54	2.63	6.18	2.10	2.08	2.18	1.20	3.01	33.33
1902	0.90	1.49	4.42	1.64	4.87	4.30	1.64	5.21	3.05	2.15	1.65	3.36	34.68
1903	2.62	1.83	3.53	1.66	0.00	3.56	4.25	3.38	0.92	1.69	0.00	2.94	26.38
1904	2.57	0.90	2.25	3.03	2.82	2.40	3.30	4.30	5.07	2.18	0.67	1.76	31.25
1905	2.56	0.79	1.76	1.40	2.82	2.89	4.10	2.66	3.35	0.79	2.02	3.59	28.73
1906	1.41	1.84	2.40	1.19	4.05	3.51	2.90	1.15	2.23	2.78	2.21	2.29	27.96
1907	1.69	1.38	1.79	4.10	0.67	2.94	3.72	1.11	5.80	3.76	3.53	2.80	33.29
1908	1.74	2.81	1.85	1.47	3.38	2.48	2.28	2.25	0.88	0.96	1.43	2.04	23.57
Av.	2.70	2.03	2.83	1.96	3.11	3.38	3.62	3.11	3.17	2.23	2.76	2.52	33.42

RAINFALL AT WATERVILLE, ME. Elevation, 200 feet.

(West Waterville.)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1863	...	...	...	...	...	...	...	3.45	2.85	4.55	3.95	3.40	....
1864	3.65	1.60	3.50	2.70	3.05	0.55	1.35	3.90	3.25	2.60	4.85	3.60	34.60
1865	4.90	2.60	4.50	4.10	2.80	1.35	5.55	1.00	0.57	3.30	3.40	3.25	37.32
1866	2.39	4.90	5.50	2.15	3.35	4.30	2.90	4.80	5.20	4.26	2.64	2.37	44.76
1867	3.70	3.20	4.55	3.42	4.87	1.65	3.70	6.90	0.78	5.30	3.05	1.75	42.87

RAINFALL AT WATERVILLE, ME.—*Continued.*

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1868	2.27	1.85	3.53	2.53	8.97	2.84	3.15	0.96	4.73	0.60	7.90	1.60	40.93
1869	2.15	6.45	4.95	2.83	4.66	4.76	0.93	2.40	5.19	13.87	3.41	6.08	57.68
1870	6.44	5.70	3.15	3.80	1.67	1.38	1.29	1.90	1.37	5.36	4.34	2.60	39.00
1871	2.93	1.98	5.63	2.75	3.20	1.15	2.99	4.98	1.66	6.39	3.87	4.52	42.05
1872	1.71	1.77	2.75	1.29	1.91	2.27	2.95	6.98	5.57	3.06	4.35	4.87	39.48
1873	4.84	3.18	4.95	2.17	3.29	1.44	3.78	0.74	3.96	6.95	3.64	1.87	40.81
1874	3.75	4.20	2.10	6.20	4.25	1.81	1.94	3.36	2.16	1.19	2.15	2.45	35.56
1875	2.70	3.35	4.54	2.15	2.73	6.57	3.04	4.00	6.77	5.10	3.61	0.79	45.35
1876	2.48	3.35	7.87	2.69	3.42	2.74	2.99	0.04	5.02	2.09	3.87	4.20	40.76
1877	2.80	0.55	6.88	2.77	0.69	0.87	1.03	5.47	0.59	4.89	6.97	1.65	35.16
1878	3.11	2.55	3.05	6.49	0.97	3.71	1.54	3.48	2.05	8.49	5.32	6.72	47.48
1879	3.67	4.15	2.62	2.52	2.78	3.31	4.11	5.95	3.96	2.55	4.70	4.19	44.51
Av.	3.34	3.21	4.38	3.16	3.29	2.54	2.70	3.56	3.30	4.75	4.26	3.28	41.77

RAINFALL AT WINSLOW, ME. Elevation, 90 feet.

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1896	0.40	3.40	6.24	1.74	2.52	2.33	3.46	3.59	5.86	2.66	2.89	1.29	36.38
1897	3.75	1.39	3.06	2.44	5.30	3.34	5.50	3.42	3.02	0.68	4.96	2.71	39.57
1898	4.67	4.91	1.05	2.44	1.51	3.42	1.95	3.09	2.77	5.38	3.86	1.59	36.64
1899	2.88	2.45	4.10	1.00	2.32	1.13	6.81	0.25	4.03	1.34	1.76	1.90	29.97
1900	6.35	6.27	5.21	1.95	6.32	4.09	4.17	2.55	3.26	4.86	5.00	1.05	51.08
1901	2.91	0.65	5.15	4.50	2.91	2.51	3.31	4.54	3.92	3.28	1.38	8.23	43.29
1902	2.31	1.49	8.90	2.51	2.24	4.61	2.62	4.43	2.29	5.54	1.17	4.25	42.36
1903	4.14	3.01	7.15	2.21	0.31	4.47	4.53	3.37	1.01	3.31	1.34	2.98	37.83
1904	2.58	1.51	3.41	5.38	4.91	1.47	2.52	4.94	5.84	2.64	1.62	1.65	38.47
1905	3.66	0.93	0.83	2.20	2.53	3.39	4.26	2.03	3.20	0.62	4.00	2.82	30.47
1906	2.78	1.33	3.33	2.78	4.64	3.28	5.18	2.96	1.16	5.86	2.96	2.24	38.50
1907	2.60	1.56	1.72	3.40	2.58	2.90	5.26	0.83	6.00	3.24	4.49	3.15	37.73
1908	2.07	3.10	1.78	2.07	5.00	2.82	2.73	2.74	0.93	3.08	1.60	2.57	30.49
1909	5.16	4.80	3.17	3.87	2.59	2.54	1.95	1.76	6.71	1.88	4.35	1.48	40.26
1910	3.12	2.41	1.86	3.14	2.67	4.10	2.90	5.52	2.51	1.46	2.43	2.78	34.90
1911	2.24	1.40	3.83	0.59	0.61	4.17	4.43	2.63	3.60	2.13	3.04	3.00	31.67
1912	3.30	2.68	4.46	2.49	5.27	0.51	3.15	4.80	2.19	3.37	3.52	2.46	38.20
1913	2.62	1.74	3.99	2.62	3.45	0.92	1.65	3.52	3.74	6.96	1.68	3.15	36.04
Av.	3.20	2.50	3.85	2.63	3.20	2.89	3.69	3.16	3.45	3.24	2.89	2.74	37.44

NEW HAMPSHIRE.

RAINFALL AT ALSTEAD, N. H. Elevation 1 120 feet.

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1894	2.11	1.85	1.33	0.97	2.40	3.72	1.69	2.84	2.56	2.68	2.25	2.52	26.92
1895	2.88	1.29	2.20	4.84	1.14	2.18	3.37	1.98	3.66	2.39	5.30	3.20	34.43
1896	0.84	4.40	5.83	1.18	1.42	1.44	3.05	5.01	5.60	3.35	2.78	0.88	35.78
1897	2.67	2.91	3.74	3.66	3.46	7.11	12.16	4.38	1.76	1.91	7.39	5.20	56.35
1898	5.19	4.76	0.84	3.58	4.30	3.05	2.16	7.40	5.34	4.89	7.31	2.96	51.78
1899	2.41	3.50	6.87	1.44	1.31	1.33	5.30	1.24	3.77	2.03	2.27	2.58	34.05
1900	5.02	8.09	4.44	1.48	3.72	3.32	2.98	5.32	2.28	3.64	7.29	2.23	49.81

RAINFALL AT ALSTEAD, N. H. — *Continued.*

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1901	1.88	0.47	4.64	5.07	5.81	1.78	5.68	5.31	3.34	2.92	1.21	7.26	45.37
1902	2.88	2.10	5.95	5.52	4.36	4.84	7.85	3.53	5.37	4.77	1.24	6.76	55.17
1903	3.13	4.02	6.13	2.27	1.33	7.37	2.76	6.29	1.38	2.45	1.84	3.85	42.82
1904	3.99	1.77	3.00	5.59	3.59	1.44	1.75	3.21	6.24	2.08	1.10	1.76	35.52
1905	4.40	0.80	2.00	**1.40**	**1.48**	**3.58**	**1.35**	4.89	6.45	1.27	2.51	3.25	33.38
1906	2.55	3.52	3.65	2.07	6.15	4.25	6.58	2.23	1.80	3.18	1.82	2.61	40.41
1907	1.87	1.12	1.86	2.77	2.91	3.49	4.00	2.19	8.33	5.64	4.64	3.38	42.20
1908	2.08	3.27	2.34	2.92	5.10	1.16	4.08	4.51	0.93	1.89	0.91	2.64	31.83
1909	3.52	3.76	1.86	3.72	2.46	4.68	3.43	3.75	4.15	1.26	1.69	1.69	35.97
1910	3.59	3.81	1.01	2.37	3.17	2.80	1.34	2.29	2.67	1.72	3.80	2.93	31.50
1911	1.65	1.98	3.23	0.92	1.70	2.59	5.82	3.79	4.05	5.83	2.80	2.59	36.95
1912	1.80	1.58	4.56	3.12	5.21	1.96	3.85	8.19	5.05	4 16	3.45	3.66	46.59
1913	2.27	2.52	5.82	2.04	3.76	0 23	3.71	2.35	2.11	4.68	1.81	2.08	33.38
Av.	2.84	2.88	3.56	2.85	3.24	3.12	4.14	4.03	3.84	3.14	3.17	3.20	40.01

RAINFALL AT ASHLAND, N. H. Elevation, 600 feet.

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1877	1.72	0.21	6.01	2.66	1.81	3.22	5.85	4.14	1.40	6.68	7.66	1.36	42.72
1878	3.65	1.61	2.33	6.70	1.27	4.84	3.48	5.24	1.84	3.97	4.11	8.52	47.56
1879	2.25	3.66	3.91	2.30	1.96	5.46	3.40	3.04	3.36	1.53	4.84	4.30	40.01
1880	4.41	2.36	1.90	3.31	3.42	3.10	6.09	2.25	2.86	4.98	3.91	2.06	40.65
1881	3.56	3.34	2.71	1.51	5.10	2.49	5.23	1.55	2.83	3.93	3.74	6.30	42.29
1882	3.48	4.13	3.29	1.77	5.52	3.67	3.36	1.12	8.85	1.07	1.05	4.01	41.32
1883	3.01	4.38	1.64	2.26	3.63	6.38	4.83	1.36	3.36	6.34	2.61	3.08	42.88
1884	5.65	5.29	5.64	2.89	3.47	3.06	3.62	4.35	1.07	2.79	3.76	5.10	46.69
1885	5.69	2.91	1.87	2.25	1.89	4.56	5.53	6.51	1.63	3.84	5.71	5.15	47.54
1886	4.84	5.27	3.14	1.43	3.76	2.77	2.09	3.54	4.09	3.53	6.11	4.40	44.97
1887	4.23	5.43	2.74	3.48	2.39	6.09	4.80	4.13	1.29	1.72	4.17	5.31	45.78
1888	4.81	4.31	4.84	3.38	5.05	2.34	1.78	...	...	...	...	...	....
Av.	3.86	3.51	3.20	2.78	3.11	4.15	4.39	3.39	2.96	3.67	4.33	4.51	43.86

RAINFALL AT BELMONT, N. H. Elevation, 600 feet.

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1885	5.06	4.09	1.42	2.09	1.93	3.40	1.54	5.95	0.97	2.39	4.70	4.46	38.00
1886	4.78	4.61	3.41	1.41	2.81	2.67	4.04	2.87	2.73	2.53	4.87	4.50	41.23
1887	4.19	5.88	3.30	2.67	2.33	5.01	5.63	6.22	1.08	1.40	3.41	4.20	45.32
1888	5.26	4.18	6.35	2.86	3.48	1.83	0.91	2.90	8.96	5.71	4.52	2.67	49.63
1889	4.43	1.61	2.90	2.06	2.56	3.81	4.64	1.28	6.29	4.51	4.27	4.28	42.64
1890	4.22	3.97	5.64	1.81	5.78	1.65	4.00	5.39	4.67	6.52	1.68	4.41	49.74
1891	6.09	4.14	4.27	2.55	2.71	2.16	5.22	4.59	2.53	2.44	2.29	4.27	43.26
1892	4.65	1.84	1.89	0.94	4.64	5.30	3.48	9.81	3.14	1.62	4.68	1.03	43.02
1893	2.92	5.65	2.87	2.37	4.21	1.47	2.37	3.44	2.54	5.59	1.85	3.92	39.20
1894	2.34	3.44	0.81	1.70	3.85	1.64	2.24	1.35	2.83	2.77	1.85	1.78	26.60
1895	2.80	0.57	2.20	5.41	2.01	2.94	4.00	3.72	3.41	2.87	5.77	4.48	40.18
1896	0.84	4.38	8.45	1.39	2.94	3.14	3.18	2.73	5.44	5.25	**3.69**	**1.01**	42.44
Av.	3.96	3.70	3.62	2.27	3.27	2.92	3.44	4.19	3.72	3.63	3.63	3.42	41.77

RAINFALL AT BENTON, N. H. Elevation, 1 200 feet.

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1909	...	...	...	...	...	...	...	3.06	4.87	0.84	1.56	0.78	....
1910	2.40	2.95	1.42	2.94	4.33	4.45	3.79	4.94	3.44	2.00	2.31	2.38	37.35
1911	1.81	1.90	1.86	0.67	2.28	1.98	4.56	4.42	3.20	4.01	3.45	2.96	33.10
1912	2.99	2.21	4.48	3.26	5.24	1.47	2.70	5.26	4.40	3.45	2.71	3.35	41.52
1913	4.03	1.60	5.74	2.32	3.73	1.84	4.86	1.42	2.81	5.73	2.97	2.53	39.58
Av.	2.81	2.17	3.37	2.30	3.89	2.43	3.98	4.01	3.46	3.80	2.86	2.81	37.89

RAINFALL AT BERLIN MILLS, N. H. Elevation, 1 100 feet.

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1887	3.66	5.31	2.38	2.20	2.37	4.78	6.72	3.80	1.18	1.89	3.53	5.00	42.82
1888	3.64	1.81	4.19	1.17	1.46	1.51	2.18	5.74	3.77	3.85	6.04	2.75	38.11
1889	4.34	1.63	3.00	1.42	1.81	4.35	4.01	1.00	5.72	3.15	3.91	3.30	37.64
1890	3.87	4.12	3.46	1.94	5.02	4.29	4.09	5.74	2.96	3.59	3.25	4.30	46.63
1891	5.21	1.94	4.91	3.01	3.87	2.15	2.99	5.84	1.85	1.89	2.46	4.56	40.68
1892	5.19	1.33	2.34	0.70	3.93	7.93	3.49	5.70	2.14	2.07	5.14	2.00	41.96
1893	2.05	4.13	2.06	2.51	3.54	3.47	2.53	5.85	2.67	3.80	2.11	4.10	38.82
1894	2.85	1.96	2.28	1.98	3.71	2.80	2.98	2.96	2.66	3.55	2.25	3.25	33.23
1895	2.86	0.89	1.36	5.93	4.00	2.32	2.97	4.30	2.19	1.71	5.38	4.48	38.39
1896	1.61	4.90	8.18	1.80	1.98	2.25	3.45	2.72	2.73	2.43	2.09	1.16	35.30
1897	2.50	1.84	2.57	3.77	5.17	5.66	7.92	1.34	2.48	2.99	5.46	1.08	42.78
1898	2.62	8.16	0.84	2.90	1.42	5.30	4.28	4.25	5.38	3.24	3.72	1.86	43.97
1899	1.98	4.26	5.73	0.54	1.92	2.85	5.43	0.76	3.84	1.73	1.89	2.91	33.84
1900	3.91	5.62	6.08	0.71	4.81	3.92	3.14	2.74	4.78	2.98	6.72	2.64	48.05
1901	1.98	0.91	3.24	5.94	4.12	2.75	3.95	2.84	2.08	3.10	1.89	5.01	37.81
1902	3.41	2.16	5.03	3.04	4.00	4.05	3.69	4.32	3.37	3.43	0.86	3.30	40.66
1903	2.41	3.06	3.59	1.34	0.19	6.91	3.44	4.26	0.80	2.07	0.77	2.20	31.04
Av.	3.18	3.18	3.60	2.41	3.14	3.96	3.96	3.77	2.98	2.79	3.38	3.17	39.52

RAINFALL AT BETHLEHEM, N. H. Elevation, 1,470 feet.

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1893	1.50	2.45	2.62	1.92	2.30	6.09	3.10	5.19	2.69	4.08	1.13	3.43	36.50
1894	2.71	1.87	1.50	1.92	2.37	3.45	2.64	2.12	3.42	2.40	1.77	1.84	28.01
1895	1.06	0.65	1.11	2.90	3.99	2.72	2.70	4.47	3.23	1.36	5.98	4.06	34.23
1896	0.57	2.69	5.06	1.25	2.44	2.09	6.01	3.73	3.98	3.37	2.68	0.98	34.85
1897	2.54	1.52	2.43	2.65	5.52	6.97	6.21	4.07	2.93	1.41	5.62	3.15	45.02
1898	2.85	5.36	1.44	3.09	2.83	5.10	2.55	7.13	5.12	4.32	4.07	2.23	46.09
1899	2.43	3.87	5.61	0.98	1.77	2.92	5.49	1.03	3.83	2.81	2.68	1.72	35.14
1900	4.98	4.71	3.98	1.45	3.30	1.73	4.13	3.65	4.16	5.02	5.77	2.06	44.94
1901	1.90	1.50	3.80	3.08	3.50	4.34	4.94	3.10	2.79	3.83	2.41	4.66	39.85
1902	1.18	2.14	4.95	3.38	5.07	5.30	4.28	3.39	3.35	5.09	1.54	2.76	42.43
1903	2.73	3.23	5.41	1.36	0.29	3.64	4.26	2.11	0.80	2.83	1.30	1.78	29.74
1904	1.98	1.30	1.68	3.01	4.09	2.51	3.08	4.53	7.30	2.88	1.66	1.41	35.43
1905	2.59	1.00	2.52	2.04	2.91	5.54	6.00	5.18	6.61	1.29	1.84	3.64	41.16
1906	1.29	2.52	2.34	1.42	5.05	5.21	3.47	4.06	2.15	4.20	1.80	1.89	35.40
1907	1.40	1.90	2.41	4.10	2.73	2.94	4.19	1.91	4.50	4.93	2.49	2.85	36.35
1908	2.49	2.43	2.16	2.56	2.84	2.28	3.74	2.68	1.19	1.81	1.75	2.73	28.66
1909	5.65	2.86	2.68	3.19	4.58	2.78	3.13	3.24	7.97	1.84	2.47	1.14	41.53
1910	3.17	2.90	1.66	3.27	4.82	4.70	4.97	5.72	3.74	1.31	2.19	2.58	41.03

RAINFALL AT BETHLEHEM, N. H. — *Continued.*

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1911	2.05	1.69	2.58	0.92	1.10	3.23	4.74	6.07	3.25	3.70	2.96	2.87	35.16
1912	2.39	1.76	2.89	2.97	6.27	2.05	2.74	5.92	6.12	1.32	2.43	2.64	39.50
1913	2.98	1.69	6.00	3.09	4.13	2.24	4.08	1.79	2.74	5.07	1.62	1.86	37.29
Av.	2.40	2.38	3.09	2.41	3.42	3.71	4.12	3.86	3.90	3.09	2.67	2.49	37.54

RAINFALL AT BRISTOL, N. H. Elevation, 600 feet.

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1877	3.25	0.14	5.75	2.36	1.41	3.68	4.66	4.16	0.63	6.14	7.47	1.21	40.86
1878	3.95	1.89	1.83	7.20	1.68	6.48	3.56	4.09	1.40	2.91	4.54	8.12	47.65
1879	2.28	3.09	4.06	2.36	1.10	5.03	2.83	2.97	3.39	1.71	4.23	4.50	37.55
1880	3.77	2.10	1.58	3.26	2.00	2.21	4.79	2.23	2.71	4.96	3.45	2.58	35.64
1881	3.73	3.50	4.09	1.23	5.50	2.25	5.96	1.39	2.06	3.93	3.05	6.08	42.77
1882	3.05	4.66	3.02	1.46	5.59	4.38	2.63	1.05	9.87	1.09	0.96	3.05	40.81
1883	2.69	4.18	1.89	2.44	3.80	3.91	4.01	1.01	3.01	5.67	4.02	3.53	40.16
1884	4.34	5.67	5.38	3.39	3.31	2.10	2.84	6.50	0.52	2.32	2.98	5.05	44.40
1885	5.79	3.54	1.74	2.16	2.15	3.01	3.79	8.58	1.84	3.65	6.52	2.44	45.21
1886	6.61	4.41	3.16	1.61	3.52	2.70	2.99	3.22	3.95	3.28	6.38	4.05	45.88
1887	3.66	4.89	2.84	3.06	2.84	6.78	6.08	3.88	1.21	1.80	3.99	5.09	46.12
1888	4.07	4.43	5.04	3.64	4.39	2.06	1.47	4.57	8.06	5.62	5.61	2.66	51.62
1889	5.89	1.95	2.29	2.24	2.68	3.70	4.55	1.99	4.42	4.37	5.03	4.91	44.02
1890	3.53	4.32	...	...	...	...	...	...	...	...	...	...	....
Av.	4.08	3.42	3.28	2.80	3.07	3.72	3.86	3.51	3.31	3.65	4.48	4.10	43.28

RAINFALL AT BROOKLINE, N. H. Elevation, 250 feet.

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1892	...	...	...	...	4.74	4.64	2.05	8.20	1.57	0.77	4.99	0.70	....
1893	2.72	5.71	3.05	2.98	6.98	2.72	1.79	8.09	2.31	4.70	2.41	3.55	47.01
1894	2.76	3.49	1.22	2.74	4.18	0.94	2.86	0.68	3.00	4.20	3.35	2.69	32.11
1895	3.54	0.55	2.72	5.38	2.18	2.63	5.72	2.76	3.12	6.03	6.51	4.09	45.23
1896	1.67	6.97	5.54	1.05	2.31	1.92	3.17	2.76	6.71	3.60	3.11	1.78	40.59
1897	3.99	3.35	3.95	2.03	4.64	6.23	8.50	3.40	2 20	0.88	6.68	6.38	52.23
1898	3.82	3.57	1.51	5.70	3 55	4.49	2.77	5.09	2.30	7.40	6.65	3.55	50.40
1899	2.00	3.35	8.62	2.03	1.83	3.97	5.36	2.39	5.71	1.51	2.25	1.87	40.89
1900	4.19	9.49	6.20	1.98	2.82	2.09	2.16	3.32	4.66	3.59	6.88	3.41	50.79
1901	1.56	0.60	5.73	9.41	6.34	2.21	4.46	5.12	2.50	4.07	1.47	6.05	49.52
1902	2.65	3.30	4.80	5.50	2.33	3.06	4.05	5.64	4 95	6.13	0.90	4.50	47.81
1903	1.90	4.00	5.88	3.58	1.28	10.25	3.71	2.99	2.15	3.82	1.87	3.08	44.51
1904	3.85	2.45	2.90	9.13	4.28	2.79	1.66	4.67	4.60	1.24	0.84	2.25	40.66
1905	5.53	1.20	3.91	2.38	1.08	8.10	2.13	5.22	6.00	1.62	2.08	4.01	43.26
1906	2.61	1.96	5.40	2.34	6.40	6.64	4.26	2.37	1.00	3.75	2.47	3.40	42.60
1907	1.85	1.85	1.85	1.70	2.99	2.94	5.01	1.54	8.75	4.83	5.03	2.54	40.88
1908	2.59	4.22	2.50	2.57	5.18	0.89	4.40	6.07	1.05	2.26	0.95	2.96	35.64
1909	3.35	5.10	3.78	4.54	2.49	1.96	1.87	3.41	4.04	1.50	2.00	4.40	38.44
1910	5.11	3.65	1.43	3.10	1.88	3.95	1.73	2.62	2.32	1.68	2.60	2.29	32.36
1911	2.31	2.40	3.91	1.80	1.64	3.07	3.27	5.30	3.02	6.20	3.55	3.05	39.52
1912	2.17	2.31	4.81	3.57	5.15	0.45	4.08	2.73	2.38	3.38	3.85	3.78	38.66
1913	2.63	3.00	5.97	2.94	4.05	1.08	0.79	3.68	3.30	7.06	3.54	2.88	40.92
Av.	2.99	3.45	4.08	3.64	3.51	3.45	3.51	3.80	3.62	3.78	3.29	3.45	42.57

RAINFALL AT CONCORD, N. H. Elevation, 350 feet.

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1853	2.99	3.87	2.89	3.32	5.15	2.75	3.78	5.09	3.21	4.31	4.43	3.06	44.85
1854	...	...	2.25	...	3.08	2.25	1.71	0.25	6.88	2.25	...	...	....
1855	...	...	...	5.25	1.00	4.23	4.75	3.25	0.25	11.00	4.25	...	....
1856	2.65	2.00	1.61	...	3.00	3.71	3.37	...	5.88	1.50	1.20	1.55	....
1857	2.75	0.54	1.50	5.68	5.97	3.20	4.81	3.90	0.52	5.12	1.64	3.97	39.60
1858	3.00	2.01	1.10	2.60	3.63	1.25	4.40	4.70	5.10	...	...	...	....
1859	3.24	1.17	0.90	1.13	0.00	6.74	3.36	4.39	5.56	2.78	2.90	2.98	35.15
1860	3.10	1.97	1.18	1.50	2.20	3.23	3.10	4.71	3.78	3.13	5.05	3.18	36.13
1861	3.25	0.81	3.95	5.30	3.83	1.66	5.61	3.52	3.05	6.86	3.13	1.73	42.70
1862	2.97	2.07	2.69	2.93	2.72	7.95	4.74	3.57	3.12	5.40	7.60	1.85	47.61
1863	3.76	3.47	5.62	3.49	2.52	4.12	6.82	6.35	2.69	5.15	6.73	3.59	54.31
1864	1.14	0.97	4.89	3.83	2.37	0.72	1.31	5.71	3.33	4.30	5.80	4.37	38.74
1865	3.97	2.15	4.02	2.61	5.41	2.55	3.76	3.30	2.00	5.03	1.64	2.71	39.15
1866	1.26	3.29	2.39	1.44	3.55	3.14	3.36	3.89	5.03	2.59	4.06	3.12	37.12
1867	2.08	1.95	3.09	3.52	3.85	2.05	4.59	9.90	1.54	3.42	2.41	1.81	40.21
1868	2.56	1.04	2.18	2.54	6.81	2.52	3.05	2.89	9.92	0.63	5.50	1.63	41.27
1869	2.63	2.71	4.50	1.45	3.18	1.54	1.14	2.01	3.46	11.65	2.19	4.13	40.59
1870	5.83	4.20	2.93	6.24	1.74	2.20	1.40	1.23	1.94	2.26	2.39	2.09	34.45
1871	1.00	2.53	3.78	4.70	3.04	2.47	4.20	5.02	1.30	4.73	3.65	3.50	39.92
1872	1.40	1.70	2.40	1.45	2.49	4.61	7.72	7.00	4.32	4.63	5.00	2.84	45.56
1873	3.98	2.20	2.82	1.97	2.15	0.89	4.08	1.85	4.06	6.15	3.05	3.38	36.58
1874	3.22	3.35	0.73	5.20	4.19	4.74	6.54	1.95	2.40	1.37	2.40	0.90	36.99
1875	3.40	2.53	4.55	3.23	2.77	3.97	2.43	5.31	2.92	6.17	3.25	1.08	41.61
1876	2.27	5.87	8.13	2.40	3.22	4.89	4.73	0.42	3.82	0.95	2.50	4.30	43.50
1877	2.20	0.40	5.28	3.26	2.98	2.63	4.77	4.60	0.85	7.62	6.23	0.84	41.66
1878	4.30	4.42	2.40	6.70	1.86	5.10	1.84	4.06	0.71	4.09	5.76	6.55	47.79
1879	2.70	3.10	3.80	3.10	4.51	4.76	4.29	4.39	3.28	0.79	3.37	3.97	42.06
1880	4.35	2.58	1.40	2.62	1.63	1.33	3.55	1.47	3.12	3.98	2.01	2.44	30.48
1881	3.51	3.65	3.83	0.95	3.28	3.34	4.38	1.25	3.52	2.96	3.04	5.89	39.60
1882	3.87	4.28	2.73	1.09	4.37	3.98	1.73	0.35	7.22	1.41	1.19	1.83	34.05
1883	1.65	3.48	1.50	2.42	3.04	2.04	5.80	1.37	1.96	3.67	1.87	2.55	31.35
1884	4.22	4.70	4.51	3.53	3.07	0.93	2.14	3.62	0.76	1.99	2.77	3.97	36.21
1885	4.45	3.50	0.88	2.54	2.18	4.85	2.15	5.32	0.96	3.63	3.65	3.60	37.71
1886	4.92	4.27	3.27	1.66	2 22	2.48	2.56	3.49	4.25	2.66	3.81	3.30	38.89
1887	3.35	4.86	3.04	3.04	2.33	4.56	7.84	7.68	0.82	1.71	3.70	3.92	46.85
1888	4.93	3 69	4.92	2.84	4.48	2.57	0.96	5.67	10.97	5.63	4.15	3.52	54.33
1889	3.82	1.78	2.51	2.09	2.46	4.21	5.63	1.57	3.86	4.21	4.98	3.88	41.00
1890	2.88	4.20	5.69	1.88	5.05	2.56	3.98	3.56	4.65	7.76	1.49	3.83	47.53
1891	5.71	3.54	4.19	2.41	2.34	3.32	3.34	2.95	2.09	2.63	1.73	4.11	38.36
1892	3.98	1.70	2.00	0.76	6.24	3.00	2.50	9.00	1.98	1.29	4.33	1.04	37.82
1893	2.59	5.48	2.58	2.47	4.15	2.18	3.13	4 11	1.38	4.77	2.53	4.03	39 40
1894	2.67	2.25	1.16	1.64	4.79	1.89	2.89	0.65	2.26	2.79	1.78	2.87	27.64
1895	3.25	0.56	2.27	4.52	2.12	1.98	3.52	3.85	2.34	4.09	5.59	4.01	38 10
1896	1.23	5.90	6.55	1.02	3.34	2.35	3.10	3.75	4.92	4.00	2.97	0.96	40.09
1897	3.72	2.49	3.87	2.38	3.93	8.35	8.56	3.58	1.22	0.58	6.59	4 78	50.05
1898	4.94	4.26	0.84	4.24	2.92	3.10	1.31	4.74	5.89	5.56	5 96	2.26	46.02
1899	2.55	2.40	5 88	1.19	0.32	1.04	4.35	1.93	4.38	0.83	2.35	1.35	28.57
1900	4.88	5.05	5.30	0.90	2.36	1.79	1.74	2.76	2.68	2.19	5.22	1.29	36.16
1901	1.39	0.47	4.05	6.87	6.09	1.87	4.51	6.68	3.08	3 61	1.34	7 20	47.16
1902	2.54	2.37	5.52	4.87	2.38	3.12	4.69	5 20	5.25	4.41	0.97	5.87	47 19
1903	3.61	3 75	5.00	1.62	0.57	7.75	6.00	3 38	1.21	3 27	1.40	3.21	40 80

RAINFALL AT CONCORD, N. H. — *Continued.*

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1904	3.69	1.71	2.33	7.44	4.02	3.80	3.42	4.45	4.68	1.60	1.58	1.81	40.53
1905	4.10	1.80	3.46	1.66	2.45	3.81	2.02	2.59	6.24	1.11	2.33	4.51	36.08
1906	1.73	1.34	2.11	1.44	5.44	5.79	3.14	2.24	1.19	3.60	2.06	3.20	33.28
1907	1.05	0.85	0.99	2.85	2.56	3.07	6.66	1.64	9.26	3.74	4.07	2.62	39.36
1908	2.07	3.31	1.68	1.85	4.25	0.29	2.07	5.58	0.45	1.62	0.81	2.27	26.25
1909	2.98	3.25	2.56	3.04	1.35	3.12	2.14	2.85	4.15	0.82	2.12	2.56	30.94
1910	4.10	4.77	1.28	3.20	1.81	3.47	0.91	1.49	3.06	1.03	2.60	2.47	30.19
1911	1.68	3.02	4.01	1.46	1.57	1.87	3.45	4.24	2.93	3.73	3.03	3.14	34.13
1912	2.59	1.66	4.89	2.58	4.70	1.06	2.43	3.39	3.14	2.54	3.74	3.71	36.43
1913	1.81	2.25	4.40	2.03	3.17	0.10	1.25	2.30	3.26	4.63	1.76	2.08	29.04
Av.	3.10	2.83	3.30	2.88	3.22	3.15	3.67	3.75	3.37	3.56	3.33	3.12	39.28

RAINFALL AT DURHAM, N. H. Elevation, 88 feet.

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1893	2.31	3.94	2.22	2.15	5.62	1.95	2.33	3.48	1.95	5.16	2.09	2.85	36.05
1894	2.17	2.84	0.99	...	...	...	...	...	...	...	...	...	....
1896	1.15	5.83	6.71	0.98	2.23	3.04	2.85	3.68	9.48	3.50	3.47	1.76	44.68
1897	4.84	2.31	4.40	2.50	4.94	8.85	6.98	2.97	2.71	0.49	6.79	5.33	53.11
1898	3.59	3.03	1.79	5.37	3.79	2.14	1.76	5.92	3.57	7.62	5.17	2.47	46.22
1899	6.70	2.01	4.76	1.38	1.08	1.14	3.99	1.00	5.12	2.15	1.97	1.64	32.94
1900	5.62	10.06	6.06	2.09	2.53	1.37	1.49	2.49	3.30	4.32	5.04	3.83	48.20
1901	1.82	0.79	5.38	7.94	4.27	0.35	3.10	1.08	3.38	3.21	1.58	7.62	40.52
1902	2.77	4.33	7.25	4.68	1.22	4.04	3.39	5.81	5.74	4.61	0.79	5.87	50.50
1903	6.05	4.32	6.63	2.34	1.07	7.70	4.92	2.67	1.73	3.74	2.04	2.25	45.46
1904	5.59	3.28	3.20	8.61	3.29	5.65	1.23	3.03	2.94	2.35	1.12	2.22	42.51
1905	7.60	1.73	2.00	1.13	0.95	5.72	2.50	2.35	10.68	1.20	2.90	7.41	46.17
1906	6.50	1.26	4.35	2.93	6.20	9.04	3.56	2.87	1.14	2.33	3.11	3.51	46.80
1907	2.30	1.98	1.32	2.94	1.89	2.62	2.19	1.54	8.40	3.43	4.38	3.59	36.58
1908	3.48	2.48	1.54	1.21	4.54	0.96	3.16	5.43	1.05	3.66	1.43	3.27	32.21
1909	1.93	3.23	1.34	3.45	1.66	2.46	1.73	2.83	4.34	1.89	2.47	2.91	30.24
1910	2.90	2.94	0.14	2.47	1.27	3.27	1.79	3.02	2.76	1.64	2.01	1.39	25.60
1911	1.37	1.89	1.23	1.27	1.10	1.83	4.96	4.26	3.09	1.89	3.16	3.61	29.66
1912	3.64	2.29	4.69	1.23	4.39	0.20	4.14	2.95	3.03	2.58	2.30	3.84	35.28
1913	0.86	2.28	2.36	2.80	4.17	0.20	0.98	4.20	1.38	7.96	0.88	1.91	29.98
Av.	3.74	3.16	3.55	3.03	2.96	3.29	3.00	3.24	3.99	3.35	2.77	3.54	39.62

RAINFALL AT ERROL DAM, ERROL, N. H. Elevation, 1 260 feet.

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1885	2.10	3.50	1.90	0.60	0.00	1.20	3.75	2.56	2.86	2.90	2.02	4.40	27.79
1886	5.60	2.60	2.20	0.50	2.27	1.47	1.90	3.71	3.37	1.30	3.63	3.40	31.95
1887	3.85	3.80	2.37	0.86	1.02	3.10	4.92	5.86	0.99	2.23	3.00	3.14	35.14
1888	2.65	3.58	4.18	4.96	3.14	4.47	1.67	5.56	4.99	4.80	4.48	2.28	46.76
1889	2.67	1.31	3.36	1.11	1.07	5.58	4.18	1.78	4.32	4.02	3.47	3.39	36.26
1890	3.87	3.34	3.04	1.65	5.92	3.75	2.19	5.74	3.62	3.54	3.24	2.67	42.57
1891	4.50	3.31	2.79	1.88	2.58	1.95	4.75	3.78	1.89	1.46	2.24	3.43	34.56
1892	3.73	1.50	1.96	0.71	3.29	8.14	4.10	6.62	2.85	1.93	3.47	1.41	39.71
1893	1.36	3.94	2.29	5.41	3.03	2.70	2.81	4.08	2.49	2.38	3.24	4.26	37.99
1894	2.97	1.80	1.70	1.63	3.08	4.59	3.02	2.79	3.16	3.12	3.92	2.51	34.29

RAINFALL AT ERROL DAM, ERROL, N. H. — *Continued.*

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1895	1.74	0.55	1.53	3.42	2.97	3.30	3.16	4.24	1.86	1.07	5.76	3.30	32.90
1896	1.01	3.53	4.99	2.78	3.26	2.56	5.00	3.70	3.49	2.99	2.30	1.17	36.78
1897	1.73	2.17	3.68	3.33	4.74	5.62	5.49	2.97	2.07	1.04	4.75	2.58	40.17
1898	3.98	5.48	1.17	2.54	0.79	3.89	2.52	3.92	5.45	3.72	3.00	1.97	38.43
1899	2.43	2.61	7.17	0.58	1.67	3.45	3.47	0.66	2.57	1.81	1.85	2.26	30.53
1900	3.53	4.85	4.77	0.94	4.80	3.89	5.41	1.51	4.25	2.89	6.48	1.51	44.83
1901	2.44	0.72	2.85	3.90	3.96	7.05	5.31	3.61	2.30	2.82	1.14	4.53	40.63
1902	1.71	1.65	3.81	2.20	4.86	3.10	2.76	6.53	4.34	3.32	1.52	4.63	40.43
1903	2.92	3.07	4.17	1.27	0.05	4.39	3.55	2.67	0.74	2.23	0.95	2.22	28.23
1904	1.80	1.89	2.42	3.35	3.27	1.65	2.22	4.74	3.96	2.81	0.88	2.50	31.49
1905	3.09	1.31	1.69	1.62	3.19	3.13	5.25	3.51	4.47	1.14	2.61	3.27	34.28
1906	2.01	2.33	2.68	1.79	4.34	4.82	2.40	2.11	1.99	3.78	2.25	2.51	33.01
1907	1.74	1.50	1.66	3.92	1.10	4.86	5.70	2.40	5.92	4.37	2.66	3.18	39.01
Av.	2.76	2.62	2.97	2.22	2.80	3.85	3.72	3.70	3.22	2.68	2.99	2.89	36.42

RAINFALL AT FRANKLIN, N. H. Elevation, 440 feet.

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1902	2.81	2.11	6.00	5.15	2.22	4.75	4.67	4.99	5.30	4.95	1.52	2.42	46.89
1903	3.88	3.98	5.60	1.72	0.50	8.98	3.33	4.01	3.28	3.38	1.52	2.42	42.60
1904	3.44	1.79	2.01	6.86	4.44	2.73	1.49	3.82	4.41	1.83	1.55	1.80	36.17
1905	3.21	1.63	2.70	1.84	1.73	3.27	4.33	3.72	7.25	1.47	2.61	3.86	37.62
1906	2.27	2.19	3.20	2.75	5.73	6.67	4.08	0.56	0.94	4.05	2.65	3.75	38.84
1907	2.31	1.33	2.18	2.30	2.45	3.31	2.93	2.60	8.85	4.67	4.44	3.31	40.68
1908	2.35	5.03	1.99	1.52	5.62	1.64	3.26	3.55	0.61	1.32	1.23	3.09	31.21
1909	4.66	4.58	3.30	3.25	2.05	3.54	3.08	1.86	3.52	0.88	2.65	2.69	36.06
1910	3.48	4.60	1.38	3.75	3.09	2.80	1.17	4.34	4.56	1.06	2.64	2.62	35.49
1911	2.26	2.86	3.05	1.34	0.78	2.70	4.29	3.99	3.84	5.20	3.39	1.96	35.66
1912	2.64	2.01	5.09	3.08	5.27	1.22	2.66	3.06	5.09	3.21	4.12	3.84	41.29
1913	3.00	2.59	5.56	2.17	4.28	0.72	3.82	4.10	3.16	5.39	1.86	3.18	39.83
Av.	3.03	2.89	3.50	2.98	3.18	3.53	3.26	3.38	4.23	3.12	2.52	2.91	38.53

RAINFALL AT GRAFTON, N. H. Elevation, 863 feet.

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1880	4.17	3.47	1.74	2.61	2.93	3.27	5.17	1.93	3.21	4.18	2.87	2.78	38.33
1881	3.36	3.77	4.76	1.29	4.65	2.71	5.08	2.22	2.27	3.95	3.03	6.22	43.31
1882	3.41	3.92	2.22	1.19	6.11	4.38	2.54	1.27	10.70	1.06	3.03	2.32	42.15
1883	2.14	3.23	2.07	2.06	2.97	1.18	5.00	1.44	2.42	4.76	2.81	0.85	30.93
1884	4.80	4.79	5.05	3.74	3.18	1.46	3.15	4.54	0.92	2.68	4.09	4.56	42.96
1885	4.39	3.00	1.94	1.81	2.31	3.72	5.56	10.00	1.75	3.06	6.00	1.90	45.44
1886	4.93	3.47	1.77	0.60	3.26	2.46	3.27	2.47	3.24	3.59	4.67	2.82	36.55
1887	4.40	4.55	3.40	2.58	3.82	5.67	7.18	4.60	1.58	2.09	3.74	3.74	47.35
1888	4.57	3.86	4.96	2.65	4.20	2.74	1.27	4.92	7.80	5.12	4.68	2.90	49.67
1889	4.06	2.32	2.38	1.85	2.34	4.41	5.15	2.37	4.25	4.18	4.82	4.49	42.62
1890	3.37	4.51	5.05	2.04	5.65	2.76	4.22	4.58	5.14	6.35	1.77	3.89	49.33
1891	5.90	3.45	4.02	2.36	2.31	3.09	4.46	4.12	1.66	2.15	2.49	4.78	40.79
1892	4.50	1.82	2.15	0.91	6.40	4.78	1.88	10.60	2.81	1.72	3.40	0.89	41.86
1893	2.21	6.65	1.61	1.78	4.13	2.73	2.53	7.21	2.36	4.57	1.63	3.16	40.57
1894	2.29	3.51	1.17	2.11	3.75	3.80	1.80	1.16	4.58	3.53	1.95	2.38	32.03

RAINFALL AT GRAFTON, N. H. — *Continued.*

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1895	1.98	0.74	0.95	5.71	1.97	4.09	4.37	3.90	2.55	2.85	5.49	4.13	38.73
1896	0.54	3.74	5.96	0.99	1 63	1.24	2.27	3.70	5.04	5.67	3.69	0.81	35.28
1897	2.85	2.56	2.59	2.27	4 90	5.29	7.30	2.59	1.23	1.20	5.07	3.81	41.66
1898	4.34	3.97	0.79	3.24	2 67	0.60	5.26	3.28	0.75	2.92	4.21	1.93	33.96
1899	2.02	2.97	5.06	1.25	0 92	2.71	7.25	1.48	3.38	1.18	1.68	1.42	31.32
1900	4.62	6.40	4.51	0.96	2.63	3.05	3.15	2.91	2.39	3.43	5.37	2.41	41.83
1901	1.80	0.60	3.62	5.75	8.57	1.33	5.30	4.36	4.24	2.92	2.20	6.63	47.32
1902	2.48	1.74	6.49	4.17	3.69	4.02	5.29	3.36	5.42	4.09	1.01	5.28	47.04
1903	3.36	3.34	4.55	1.89	0.56	8.07	3.92	3.19	1.00	3.27	1.20	2.83	37.18
1904	2.49	1.88	2 42	6.05	4.17	2.80	2.24	3.43	5.13	2.22	1.25	1.26	35.34
1905	3.40	2.10	2.22	1.52	1.98	3.79	4.56	4.07	5.31	1.50	2.10	2.75	35.30
1906	1.36	1.12	3.05	2.15	6.76	5.23	5.44	1.03	0.71	2.86	2.32	1.50	33.53
1907	**1.54**	2.15	2.12	2.98	2.30	2.92	2.42	1.27	6.53	5.28	3.59	2.66	35.76
1908	1.80	4.60	1.55	2.29	5.08	0 60	5.26	3.28	0.75	1.69	0.79	2.34	30.03
1909	4.12	3.62	3 20	2.51	2.74	3.48	2 03	1 79	4.00	1.00	2.20	2.27	32.96
1910	3.80	4.35	1.02	3 91	3.02	2.47	1.74	3.56	3.92	0.75	2 82	2.55	33.91
1911	2.08	2.15	3.42	0 91	1.39	3.43	4.69	2.49	3.44	4.04	2.69	2.15	32.88
1912	2.02	1.49	3.85	2.38	5.35	1.25	2.55	5.45	4.09	3.60	3.77	3.12	38.92
1913	2.98	1.70	5.53	1.94	3.52	**0.55**	**2.05**	2.89	2.37	4.79	3.10	2.73	34.15
Av.	3.18	3.16	3.15	2.43	3.59	3.12	3.98	3.57	3.44	3.18	3.10	2.95	38.85

RAINFALL AT HANOVER, N. H. Elevation, 603 feet.
(Dartmouth College.)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1835	1.90	0.70	2.23	2.99	3.31	4.86	2.99	4 22	1.80	2.42	2 21	1.61	31.24
1836	3.85	6.25	2.09	2.29	3.71	3 06	2.17	1.92	1.67	3.41	3.14	3 74	37.30
1837	3.57	2.98	1.57	2 80	5.93	3.89	4.33	2.14	1.33	2.81	2.61	1.55	35.51
1838	2.63	1.65	1 82	1.42	4.95	7.27	1.78	4.19	4.05	3.93	3.90	2.75	40.34
1839	2.20	1.35	1.53	1.39	2.26	5.42	4 29	2.03	3.05	1.01	2 47	5.05	32.05
1840	2.00	2.57	4.74	6.00	3 06	3.29	3 05	2.33	7.03	3.53	4.20	3 28	45.08
1841	6.76	1.80	3.56	5.45	1.91	2.54	2.62	2.26	4.24	1.19	2.54	4 31	39.18
1842	1.32	4.28	3 43	2.82	4.31	2.90	4.74	5.45	5.28	3.51	4.65	3.98	46.67
1843	3.50	4.50	4.24	5.24	3.90	5.92	2.76	9.00	2.05	7.59	4.50	2.65	55.85
1844	3.85	2.10	4.34	1.28	3.64	3.84	4.98	6.28	2.16	8.19	1.86	4.14	46.66
1845	4.45	3.90	3.50	3.84	1.83	1.67	1.88	3.37	3.13	2 25	4.90	3.61	38.33
1846	2.48	2.55	2.82	1.67	4.77	4.38	3.37	1.73	4.11	2.66	3 67	3.52	37.73
1847	5.10	2.46	3.22	2.55	3 84	4.47	3.78	4.62	3.74	5 65	1.65	4.80	45.88
1848	3 30	2.65	2.90	1.83	6.65	2 11	6.55	5.51	3.15	5.64	3.32	4.87	48.48
1849	0.75	1.70	2.55	1.35	3.60	3.35	1.60	9.46	1.67	5.86	4.25	2.06	38.20
1850	2.00	1.68	1.20	4.33	7.37	3.54	4.18	2.86	1.83	4.87	2.18	4.27	40.31
1851	9.75	3.28	4.85	2.72	2.66	2.55	4.75	1 28	1.80	7.94	4.94	3.75	50.27
1852	1.52	2.15	3.02	4.87	0.55	4.89	3.76	2.56	2.37	2.41	3.95	3.60	35.65
1853	0.31	4.70	1.92	2.03	5 81	1.75	1.88	3.20	4.87	3.98	4.42	2 62	37.49
1854	2.88	2.77	2.13	4.14	3.46	3.92	1.24	0.12	5.32	2.46	3.58	2.11	34.13
1855	3.80	1.69	0.98	2.72	1.32	6.40	4 74	3.59	2.20	7.29	2.27	2.88	39.88
1856	1.69	0.75	1.25	1.57	...	1.97	3.14	9.83	...	...	...	2.33	...
1857	...	...	...	...	...	...	...	...	...	...	...	...	...
1858	...	...	...	...	...	...	...	...	...	...	...	...	...
1859	...	...	...	...	...	...	...	...	...	...	...	...	...
1860	...		...	...	...	...	...	...	...	...			...

RAINFALL AT HANOVER, N. H. — *Continued.*

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1861	...	...	...	...	...	...	...	...	...	...	...	...	...
1862	...	...	..	...	...	...	...	...	0.94	2.30	...	...	...
1863	...	...	0.45	...	1.06	1.49	7.02	5.86	1.81	1.44	1.68	2.75	..
1864	1.80	0.75	1.28	1.83	1.82	0.73	0.51	...	2.61	3.68	3.42	1.79	...
1865	...	0.50	...	3.00	1.40	3.30	1.17	...	2.13	2.82	2.08	...	...
1866	...	...	...	1.59	1.56	2.97	1.49	...	3.41	3.24	1.89	0.68	...
1867	1.35	1.35	1.14	**2.35**	3.71	4.04	1.28	4.61	1.89	3.27	1.35	**2.64**	28.98
1868	1.70	0.65	2.42	2.44	6.44	5.43	1.35	3.94	6.46	1.00	**2.80**	1.45	36.08
1869	2.05	1.44	4.53	3.45	2.54	3.46	2.67	**3.59**	6.13	9.29	0.86	1.79	41.80
1870	5.81	3.45	2.25	2.90	2.53	3.17	1.82	1.13	1.68	3.50	1.59	1.15	30.98
1871	0.45	0.32	2.64	1.63	2.86	2.16	1.20	**3.59**	1.32	1.89	2.14	2.49	22.69
1872	1.46	1.40	1.62	0.38	3.42	4.34	5.63	7.35	2.64	1.57	0.75	2.28	32.84
1873	3.10	1.75	3.54	1.32	1.21	1.74	5.91	1.52	3.83	5.57	2.38	1.65	33.52
1874	2.90	1.81	0.68	3.40	3.26	3.44	5.07	2.01	3.92	1.30	1.92	1.08	30.79
1875	3.92	1.20	2.55	0.72	3.94	4.98	2.70	4.51	1.94	3.94	1.63	0.78	32.81
1876	1.72	3.59	3.45	1.32	1.32	3.46	**3.39**	0.42	4.58	0.53	2.13	4.30	30.21
1877	2.70	**2.38**	2.57	1.97	1.03	4.28	8.48	4.01	0.91	4.67	3.81	0.96	37.77
1878	1.92	1.70	0.28	3.01	1.09	3.40	2.62	2.44	1.66	1.30	3.50	4.69	27.61
1879	2.85	2.38	3.01	2.52	0.81	4.05	2.77	3.46	3.43	1.68	4.58	1.97	33.51
1880	3.18	1.29	1.06	1.65	1.68	1.83	2.39	3.23	2.06	2.84	2.23	1.51	24.95
1881	2.97	1.21	2.02	0.07	3.61	**3.51**	**3.39**	0.85	1.92	2.50	2.47	3.96	28.48
1882	1.66	2.11	0.98	0.86	3.79	3.05	2.70	1.55	6.46	0.77	0.59	1.81	26.33
1883	1.07	2.02	1.07	1.31	2.71	2.73	4.30	0.85	2.38	2.89	1.38	1.87	24.58
1884	2.01	3.06	3.11	2.29	2.74	2.87	1.66	3.83	0.27	1.40	3.45	2.75	29.44
1885	3.08	2.20	1.12	1.93	1.79	2.39	2.62	7.77	2.19	2.96	6.62	2.03	36.70
1886	3.47	1.24	2.13	1.11	2.55	2.36	1.75	2.84	2.71	2.45	4.94	1.99	29.54
1887	4.82	7.67	2.43	1.54	3.55	2.74	6.13	3.14	0.91	1.89	2.98	3.45	41.25
1888	3.75	2.20	5.25	2.39	3.28	4.65	1.99	4.64	5.86	4.05	5.14	2.37	45.57
1889	3.28	2.17	2.65	0.97	1.84	3.61	5.48	1.78	3.52	4.60	4.76	2.85	37.51
1890	2.48	2.75	3.24	1.57	5.40	2.63	3.85	7.77	3.99	4.75	1.86	2.80	43.09
1891	4.52	2.40	2.32	2.21	1.90	3.55	4.34	3.21	1.54	1.50	2.00	2.88	32.37
1892	3.37	1.41	1.40	0.93	6.26	7.42	1.93	6.25	1.72	1.54	2.53	0.96	35.72
1893	1.32	6.43	2.12	1.64	3.09	4.72	2.97	4.85	2.38	3.00	0.94	3.59	37.05
1894	2.16	2.02	1.10	1.71	3.38	2.12	2.26	2.18	3.56	2.82	2.46	2.45	28.22
1895	1.96	0.85	1.99	4.26	1.69	2.77	2.63	3.40	2.56	1.41	5.17	3.05	31.74
1896	0.67	3.95	8.25	0.83	1.27	2.51	3.23	3.07	5.36	3.92	2.30	0.71	36.07
1897	2.88	1.64	3.05	2.60	6.07	5.55	7.97	1.70	1.57	1.29	5.78	3.28	43.38
1898	4.89	3.99	1.17	2.82	2.71	4.30	1.20	3.94	4.53	3.56	3.71	1.40	38.22
1899	2.19	1.89	5.34	0.90	0.93	3.48	4.49	2.61	4.14	1.60	1.89	1.85	31.31
1900	3.35	4.89	3.69	0.92	3.23	2.48	2.40	2.89	1.35	3.17	5.15	2.07	35.59
1901	1.78	0.39	3.71	3.35	5.71	1.44	5.13	3.28	3.53	1.77	1.35	3.44	34.88
1902	1.56	2.00	3.80	4.24	3.57	3.81	3.91	3.38	4.70	4.23	1.16	4.29	40.65
1903	3.03	3.11	4.90	0.97	0.84	6.14	4.64	3.80	1.17	2.20	0.99	2.94	34.73
1904	2.85	1.06	1.71	4.15	3.35	1.48	2.51	3.73	6.03	2.40	0.93	1.57	31.77
1905	1.90	1.16	2.51	1.96	2.03	5.15	6.67	4.05	6.10	1.02	1.65	2.34	36.54
1906	1.26	2.23	2.19	1.55	6.95	3.49	3.67	2.48	1.54	3.09	1.93	2.69	33.07
1907	1.49	0.93	2.08	4.04	3.24	3.88	2.16	1.16	6.26	4.65	3.15	3.28	36.32
1908	1.56	3.04	1.24	2.18	3.99	2.17	2.32	2.84	1.14	1.90	0.94	2.44	25.76
1909	4.14	3.87	2.07	2.47	3.15	3.00	0.58	3.38	3.45	1.15	2.05	1.90	31.21
1910	2.50	3.55	0.92	2.70	3.25	3.45	1.44	3.91	3.66	1.12	2.49	2.38	31.37
1911	1.41	3.08	3.30	0.97	1.29	3.29	8.26	3.40	3.47	3.95	2.00	1.92	36.34
1912	2.35	1.27	3.23	2.51	7.00	0.62	2.69	3.52	4.19	4.70	2.30	2.60	36.98
1913	2.92	1.66	6.02	1.43	4.51	0.94	3.16	2.04	1.69	4.31	1.85	3.50	34.06
Av.	2.76	2.44	2.68	2.33	3.31	3.53	3.43	3.44	3.16	3.23	2.82	2.70	35.83

RAINFALL AT KEENE, N. H. Elevation, 506 feet.

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1892	2.72	2.18	1.07	0.47	5.61	5.19	3.37	7.22	2.46	0.91	3.22	1.00	35.42
1893	2.08	7.02	1.97	2.20	3.63	3.21	2.06	8.96	2.45	3.54	1.40	3.62	42.14
1894	1.91	2.20	1.21	1.68	3.48	2.49	2.56	1.05	3.55	2.18	2.04	2.77	27.12
1895	2.56	0.93	1.89	4.51	1.76	3.38	4.62	3.91	2.80	3.05	5.34	3.10	37.85
1896	0.89	2.88	6.19	1.45	2.05	1.46	3.09	2.81	5.51	3.24	2.37	0.81	32.75
1897	2.55	1.79	4.08	2.74	3.62	5.71	10.19	4.01	1.77	1.86	6.04	5.17	49.53
1898	4.68	3.22	0.97	3.58	4.58	3.41	1.25	4.87	3.27	6.67	5.05	2.45	44.00
1899	2.68	3.19	6.02	1.14	2.39	2.80	5.28	1.78	3.83	1.23	1.80	1.71	33.85
1900	4.35	6.46	4.28	1.86	3.62	2.61	4.39	3.42	2.79	3.15	5.68	2.07	44.68
1901	1.69	0.60	4.61	3.77	5.48	1.95	5.65	6.37	3.31	4.36	1.79	6.70	46.28
1902	1.99	2.32	3.86	3.79	3.40	3.98	4.95	4.26	4.18	4.14	0.82	5.55	43.24
1903	2.73	3.58	4.67	2.13	0.79	6.17	2.09	4.27	1.88	2.16	1.80	2.72	34.99
1904	2.91	1.45	2.21	5.02	2.70	1.98	2.48	5.37	4.91	1.95	1.91	1.66	34.55
1905	3.45	1.30	2.73	1.40	1.48	3.58	1.35	5.01	6.55	1.12	2.04	3.25	33.26
1906	2.14	2.28	3.46	2.03	5.16	3.14	4.88	1.75	1.44	3.63	2.03	3.11	35.05
1907	1.99	1.48	1.68	2.51	2.76	2.82	5.85	2.34	7.73	4.83	3.44	3.47	40.90
1908	2.20	3.16	2.67	3.02	3.94	0.78	4.70	4.59	0.72	1.35	1.00	2.46	30.59
1909	4.39	3.83	2.15	3.81	1.92	2.63	1.48	4.20	4.12	1.15	1.60	2.64	33.92
1910	4.01	4.03	1.02	1.95	2.34	2.16	2.55	1.41	4.31	1.41	3.04	1.90	30.13
1911	2.12	1.78	3.55	1.45	0.88	1.91	3.69	3.90	4.32	5.88	2.70	2.54	34.42
1912	1.91	1.58	4.64	3.05	4.32	1.72	2.77	4.10	4.86	2.24	3.12	3.93	38.24
1913	2.77	2.50	5.76	1.81	4.10	0.41	2.01	2.86	1.65	3.34	1.42	2.67	31.30
Av.	2.67	2.72	3.21	2.50	3.19	2.89	3.69	4.02	3.56	2.88	2.71	2.97	37.01

RAINFALL AT LAKEPORT, N. H. Elevation, 500 feet.

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1857	4.08	2.32	1.99	5.86	5.83	3.35	2.46	6.69	1.42	7.39	2.60	4.18	48.17
1858	2.87	1.89	1.62	3.14	3.24	2.80	4.71	4.10	4.95	5.99	2.96	3.46	41.73
1859	5.01	2.48	7.74	3.03	2.42	4.58	3.14	2.26	3.92	1.93	3.77	4.54	44.82
1860	0.52	1.99	1.97	1.35	2.00	2.35	4.60	4.52	4.55	2.95	6.06	3.54	36.40
1861	4.41	3.27	3.58	4.30	4.18	2.24	2.82	2.74	4.39	4.85	3.81	1.97	42.56
1862	4.37	2.93	5.01	2.04	2.55	4.35	2.59	3.49	3.17	3.93	6.52	2.56	43.51
1863	4.82	2.95	4.88	3.29	2.35	1.00	7.65	5.64	2.71	3.88	4.11	5.03	48.31
1864	2.30	1.46	5.54	3.79	2.57	0.31	0.63	3.80	3.42	3.55	5.66	3.46	36.49
1865	3.79	2.70	4.74	4.02	5.78	1.70	3.84	2.98	2.44	4.39	2.38	2.62	41.38
1866	1.81	4.01	2.93	1.41	3.35	3.36	5.43	2.53	6.42	2.46	2.92	3.07	39.70
1867	0.93	3.21	1.74	4.95	4.57	3.27	2.98	8.30	0.88	4.13	2.10	2.16	39.22
1868	1.96	1.31	1.34	2.54	7.37	1.93	2.92	4.03	9.50	0.97	6.31	1.36	41.54
1869	2.54	4.26	4.58	2.30	3.51	2.41	2.66	2.66	3.20	11.54	2.04	5.01	46.71
1870	5.97	6.02	3.28	7.08	1.18	0.85	2.53	1.79	1.37	3.40	3.67	1.84	38.98
1871	1.58	2.54	4.06	3.47	3.59	2.01	3.83	3.98	1.72	4.45	6.15	2.96	40.34
1872	1.61	2.67	1.99	1.87	3.21	5.53	4.29	6.83	8.73	2.83	5.30	3.33	48.19
1873	4.47	2.40	3.29	2.34	1.97	1.99	8.00	0.93	4.94	6.64	3.11	3.08	43.16
1874	3.67	3.44	1.05	5.45	4.81	4.19	7.78	2.19	4.92	1.77	3.12	1.26	43.65
1875	3.25	3.28	3.64	2.69	3.20	5.15	2.78	6.04	1.82	6.03	4.75	1.34	43.97
1876	3.31	5.75	9.01	2.79	1.81	4.17	4.83	0.31	4.29	1.01	2.97	4.67	44.92
1877	2.51	0.38	4.81	2.98	2.08	2.92	5.47	3.09	1.21	6.49	6.78	1.49	40.21
1878	4.75	2.58	2.63	5.24	1.20	4.98	2.63	4.00	1.29	3.91	5.33	6.88	45.42
1879	2.73	3.15	3.78	3.17	1.49	6.68	3.99	4.40	3.21	0.91	4.49	3.88	41.88

RAINFALL AT LAKEPORT, N. H. — *Continued.*

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1880	4.58	2.31	1.85	2.62	2.97	2.52	4.86	2.24	3.51	5.35	2.95	2.55	38.31
1881	4.10	2.97	5.21	1.24	4.37	3.11	4.33	4.48	2.81	3.53	3.26	5.62	45.03
1882	3.72	4.52	3.27	1.33	4.87	4.22	2.01	0.46	7.88	1.31	0.82	2.55	36.96
1883	2.15	4.36	2.03	2.65	3.08	2.98	4 61	1.22	3.02	4.75	2.61	3.19	36.65
1884	4.16	5.02	5.31	3.40	3.13	1.88	4.32	3.32	0.83	2.18	3.52	4.12	41.19
1885	4.71	4.37	1.45	2.58	1.94	2.92	3.72	7.97	1.45	2.49	5.86	4.49	43.95
1886	4.23	4.72	3.68	2.19	2.94	2.33	4.90	3.56	3.76	3.02	5.22	4.75	45.30
1887	3.56	5.25	3.57	2.49	2.02	5 87	6.83	4.28	2.02	1.53	3.48	4.53	45.43
1888	5.46	4.39	6.01	3.15	3.83	2.38	1.61	4.04	9 32	5.71	6 69	3.01	55.60
1889	5.42	1.94	3.04	2.36	2.32	4.55	3.86	1.74	5.29	4.77	5.39	4.02	44.70
1890	3.76	4.28	5.21	2.01	6.39	2.71	4 58	4 99	6.23	6.16	1.83	4.97	53.12
1891	6.71	3.98	4.36	2 14	2.84	2.42	5.65	3.16	1.58	2.43	2.43	4.32	42.02
1892	4.17	1.84	2.20	0.86	6.26	5.17	2.70	8.66	2.81	1.66	4.70	0.99	42.02
1893	2.94	7.06	2.97	2.57	4.43	2.66	2.75	4.32	2.63	4.96	1.58	4.15	43.02
1894	3.55	3.22	1.63	1.63	3.96	2.47	2.35	2.58	3.25	2.76	1.95	2.11	31.46
1895	3.05	0.65	2.11	5.25	2.05	2.54	3.58	4.25	3.70	3.80	4.35	4.31	39.64
1896	0 92	6.12	8.49	1.31	3.03	2.76	3.27	2.70	4.59	5.36	3.69	1.01	43.25
1897	4.34	2.95	4.01	2.68	4.95	6 92	6.03	2.90	1.20	0.80	6 61	6.30	49.69
1898	7.11	4.99	1.27	3.86	3.00	3.83	1.63	2.53	3.36	4.74	5.74	4.41	46.47
1899	2.89	3.22	7.35	1.48	1.87	2.11	4.82	1.81	3.04	1.40	2.20	1.88	34.07
1900	5.97	9.83	7.43	1.54	2.22	2.77	1.75	3 27	2.77	3.48	6.64	3.28	50.95
1901	2.28	0.79	5.52	5.70	7.02	1.10	4.88	5.38	2.53	3.68	1.88	7.33	48.09
1902	3.06	3.86	5.64	5.57	2.28	4.30	4.00	4.97	5.05	4.43	1.31	7.30	51.77
1903	4.08	4.93	5.82	2.27	0.62	6.42	4.26	3.39	1.15	3 26	1.22	4.13	41.55
1904	3.27	2.20	3.09	6.43	3 41	3 77	2.26	3 74	5.64	1.75	1.54	1.92	39.02
1905	5.58	1.58	3.54	1.75	1.66	2.83	3.99	2.74	6.66	0.99	2.78	4.28	38.38
1906	2.62	2.79	3.83	2 77	4.97	4.47	3.15	0.52	0.79	4 70	2 72	4.28	37.61
1907	2.22	1.80	3.03	3.27	2.41	2.31	2.93	1 80	7.88	4.46	5.02	3.64	40.77
1908	2.56	5.39	1.91	2.25	4.66	0.34	5.35	3.26	0.44	1.64	1 17	3.36	32.33
1909	5.30	4 61	3.96	2.94	2.34	3.03	3.22	2.18	3.65	0.79	2.64	2.48	37.14
1910	3.38	5.01	1.51	3.99	2.84	2.30	1.79	2.74	3.72	0.81	2.62	3.02	33.73
1911	2.45	3.57	4.68	1.42	0.47	2.89	3.62	3.12	4.04	4.00	3.55	3.08	36.89
1912	3.70	2.68	5.05	2.99	4.17	1.10	2 94	2.60	3.28	3.19	4.40	4.16	40.26
1913	2.81	2.67	5.78	2.26	4.23	0.34	1.65	2.71	3.55	4.81	2.23	3.78	36.82
Av.	3.58	3.45	3.88	3.02	3.29	3.10	3.80	3.52	3.65	3.62	3.71	3.56	42.18

RAINFALL AT LITTLETON, N. H. Elevation, 1 032 feet.

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1898	4.42	3.02	1.39	0.90	1.46	5.36	1.98	7.30	4.57	3.15	2.94	1.75	38.24
1899	1.56	4.43	4.98	0.86	1.16	**2.95**	4.94	0.97	3 43	2.63	4.06	2.46	34.43
1900	4.63	3.74	3.72	1.14	2.98	1.36	3.59	3.74	3.65	4.16	**5.85**	1.74	40.30
1901	1.98	1.39	3.68	2.42	3.86	3.21	5 75	2.69	1.73	**2.51**	1.91	4.51	35.64
1902	1.91	3.02	3.54	4.65	5.73	4 56	1.13	2.81	3.11	4 64	1 97	2 03	42.10
1903	2.61	3.61	4.95	1.47	0.07	5 72	4.30	**2.22**	0.88	2.99	1 29	2.21	32.32
1904	4.12	1.48	2.31	3 77	**3.72**	**2.54**	**3.24**	4.94	6 60	2.81	**1.68**	**1.46**	38 67
1905	2 66	**0.92**	**2.20**	**1.91**	**2.65**	**4.14**	3.57	7 31	4 63	1.09	**1.86**	4 90	37 84
1906	1.45	1.86	2.07	**1.33**	**4.60**	4 48	3 08	3.41	..	...		...	.
Av.	2.99	2.70	3.35	2.14	2 70	3.73	3.91	3.99	3.57	3.00	2.70	2.63	37.44

RAINFALL AT MANCHESTER, N. H. Elevation, 200 feet.

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1875	3.20	1.50	3.90	0.60	2.68	4.21	2.44	3.90	2.73	4.47	3.05	0.56	33.24
1876	0.54	1.98	4.26	2.41	3.00	2.13	4.79	0.40	4.06	1.25	2.94	4.31	32.07
1877	1.36	0.53	4.41	3.29	1.92	1.47	3.31	4.46	0.61	7.05	6.13	0.37	34.91
1878	4.94	3.39	3.01	6.92	0.25	4.23	2.88	4.62	0.81	4.55	6.21	4.70	46.51
1879	0.11	1.45	0.78	2.38	3.44	5.23	4.00	4.36	3.08	0.97	2.34	2.35	30.49
1880	3.02	1.49	0.68	2.51	1.45	1.87	5.03	1.37	1.65	3.67	2.22	2.34	27.30
1881	2.95	3.52	3.50	1.50	3.59	3.12	3.83	0.88	3.84	3.32	3.66	5.20	38.91
1882	3.20	4.48	2.99	1.11	5.05	2.41	2.58	0.16	7.03	1.60	0.53	2.00	33.14
1883	3.00	2.48	1.70	2.40	3.79	1.60	5.44	0.95	2.20	4.22	1.72	1.97	31.47
1884	4.63	5.22	4.23	3.00	3.00	1.37	1.95	3.93	1.47	1.78	3.02	5.01	38.61
1885	5.82	3.41	1.60	3.13	2.65	2.94	2.89	4.43	1.18	3.60	4.24	2.64	38.53
1886	5.65	5.37	3.02	2.36	2.22	2.21	2.29	2.50	2.71	2.56	3.02	3.32	37.23
1887	4.11	4.12	4.11	3.15	2.62	3.77	7.12	6.30	0.79	2.11	3.43	3.10	44.73
1888	3.68	4.48	5.00	3.60	3.83	0.71	1.30	3.90	7.97	5.27	4.09	3.88	47.71
1889	3.06	2.03	2.50	2.82	2.39	2.82	5.18	1.40	3.04	3.84	5.40	3.92	38.40
1890	2.66	3.75	6.41	1.77	4.33	2.65	3.25	4.08	4.45	6.72	1.34	3.15	44.56
1891	6.22	3.47	4.63	1.65	1.54	3.46	3.01	1.77	1.33	2.26	1.96	3.95	35.25
1892	3.80	2.00	2.55	0.81	6.14	4.47	1.89	5.34	1.51	0.96	4.47	0.95	34.89
1893	2.47	5.65	2.78	2.36	4.98	1.55	1.50	4.35	1.88	3.96	2.14	4.31	37.93
1894	2.34	2.49	1.19	2.11	4.63	0.41	2.47	0.89	3.11	2.71	2.24	2.08	26.67
1895	2.54	0.60	2.90	4.72	2.39	2.87	5.18	2.66	2.05	4.42	6.38	3.44	40.15
1896	2.41	4.28	6.97	0.95	2.60	0.92	2.22	3.17	5.41	3.09	2.66	1.57	36.25
1897	3.64	2.51	3.69	2.48	4.00	6.56	6.46	4.12	1.34	0.53	6.25	5.06	46.64
1898	6.84	3.02	1.37	4.85	3.10	2.97	1.50	4.70	3.44	6.77	5.04	2.45	46.05
1899	3.28	3.19	7.07	1.83	1.34	1.91	3.97	1.32	6.34	1.23	2.29	1.49	35.26
1900	4.91	8.78	5.55	1.59	2.71	1.61	1.14	2.60	3.17	3.46	8.47	2.92	46.91
1901	2.20	0.78	5.18	6.90	6.12	1.32	2.90	5.63	2.25	4.00	1.53	8.29	47.10
1902	2.22	2.28	6.18	5.57	3.47	3.59	3.64	4.63	5.01	5.41	0.87	5.45	48.32
1903	3.39	4.08	5.77	1.92	0.57	9.31	3.54	2.62	2.00	3.54	1.69	3.58	42.01
1904	3.65	1.87	2.41	8.55	3.72	2.48	1.40	3.01	4.24	1.05	1.78	1.98	36.14
1905	4.07	1.59	3.21	2.08	1.83	5.65	2.03	3.95	6.40	1.14	2.04	4.62	38.61
1906	2.42	2.36	4.92	2.47	7.10	6.32	3.34	2.86	1.13	3.55	3.07	3.80	43.34
1907	3.34	1.66	1.94	2.52	2.69	3.39	4.67	1.07	9.45	3.83	4.67	3.37	42.60
1908	2.27	4.55	2.51	1.83	4.28	0.61	4.57	6.01	1.16	2.06	0.91	3.31	34.07
1909	3.86	4.98	3.27	3.83	1.58	2.14	1.28	3.10	4.56	0.95	2.73	3.38	35.66
1910	3.94	4.94	1.55	2.96	1.40	3.33	2.87	1.74	3.17	0.95	2.47	2.31	31.63
1911	2.15	2.70	4.09	1.82	1.26	2.01	4.14	4.34	2.45	4.26	3.21	3.23	35.66
1912	2.66	2.17	5.92	2.82	5.23	0.59	3.24	2.65	3.49	2.74	3.30	4.11	38.92
1913	1.97	2.62	5.45	2.34	3.36	0.26	1.10	3.10	3.63	5.85	1.90	2.99	34.57
Av.	3.30	3.12	3.67	2.87	3.14	2.83	3.24	3.16	3.23	3.22	3.22	3.27	38.27

RAINFALL AT MT. WASHINGTON, N. H. Elevation, 6 293 feet.

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1859	...	...	...	...	...	3.87	5.47	7.67	...	...	...	...	....
1871	...	...	...	...	...	...	...	...	3.71	6.10	3.42	0.85	...
1872	1.67	0.30	0.89	0.07	4.64	18.46	3.59	6.41	9.56	5.53	4.01	1.38	56.51
1873	3.39	5.20	5.81	2.72	4.55	3.20	13.54	5.81	13.66	9.23	5.50	5.95	78.56
1874	4.40	2.47	6.71	5.74	6.53	13.44	7.97	9.51	5.52	3.02	2.34	3.07	70.72
1875	1.82	1.00	2.13	2.00	2.50	6.83	7.40	7.95	11.34	6.30	2.67	3.84	55.78

RAINFALL AT MT. WASHINGTON, N. H.—*Continued.*

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1876	2.80	3.50	6.21	3.12	7.83	9.32	14.51	2.20	14.89	3.21	3.49	6.48	77.56
1877	2.06	0.33	11.64	3.40	3.72	8.78	11.27	11.11	2.79	7.75	17.55	6.01	86.41
1878	8.54	5.88	10.66	23.41	9.28	7.67	11.00	11.35	7.37	5.78	4.78	8.77	114.49
1879	7.13	7.01	7.51	6.79	4.40	11.84	10.23	9.55	6.53	5.03	9.53	5.56	91.11
1880	4.24	2.56	4.87	3.47	5.51	5.86	7.24	5.82	15.23	7.96	9.37	7.80	79.93
1881	3.94	6.62	8.51	5.08	12.50	7.03	9.93	11.96	6.13	18.38	15.10	15.95	121.13
1882	7.20	5.94	14.52	11.20	8.91	11.40	10.03	2.81	13.32	6.19	3.25	2.64	97.41
1883	4.16	5.65	4.18	6.29	9.10	11.30	11.14	6.06	6.90	5.55	3.72	2.66	76.71
1884	2.45	7.55	4.16	3.29	9.54	8.08	23.90	8.63	7.58	12.91	7.99	4.70	100.78
1885	5.49	1.87	0.95	2.66	2.29	11.34	11.34	14.26	5.56	11.11	6.67	4.83	78.37
1886	4.85	9.03	3.11	3.36	3.25	6.09	6.30	8.34	8.52	5.09	6.48	3.10	67.52
1887	4.27	1.59	2.88	5.17	4.23	9.78	15.16	5.51	4.03	...	...	...	...
1888	...	...	...	...	...	...	6.58	14.31	9.48	...	...	...	...
1889	...	...	...	...	...	...	13.18	7.78	7.01	...	...	...	...
1890	...	...	...	...	...	...	7.00	15.39	9.31	...	...	...	...
Av.	4.28	4.33	6.12	5.51	6.30	9.37	10.63	8.12	8.99	7.54	6.83	5.51	83.53

RAINFALL AT NASHUA, N. H. Elevation, 125 feet.

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1884	4.99	4.55	4.84	4.03	3.22	2.28	2.07	4.42	1.31	1.72	2.00	4.73	40.16
1885	4.77	3.75	0.83	3.15	3.39	4.59	2.76	5.75	1.48	3.91	4.20	2.58	41.16
1886	5.86	5.71	2.99	1.62	2.70	1.79	3.12	2.71	4.13	2.37	4.66	4.51	42.17
1887	5.43	4.83	4.43	3.37	1.87	3.34	7.95	5.50	1.18	2.36	3.31	4.07	47.64
1888	4.21	4.17	5.06	3.25	2.64	1.67	1.63	4.02	9.54	6.35	4.37	3.94	50.85
1889	3.42	1.72	2.17	2.76	4.19	1.84	7.00	2.36	3.34	4.64	5.65	3.24	42.33
1890	2.57	4.21	7.11	1.42	4.88	3.39	3.85	5.86	6.01	7.39	1.30	5.03	53.02
1891	6.61	4.25	5.43	2.95	2.13	3.33	3.28	1.60	1.58	2.33	2.18	3.50	39.17
1892	4.54	2.71	3.11	0.51	5.39	3.78	2.29	5.28	1.49	1.09	5.25	0.96	36.40
1893	2.29	7.23	2.79	2.68	6.27	2.71	1.84	4.86	1.82	3.35	1.92	4.81	42.57
1894	2.84	2.95	0.93	2.49	3.58	0.34	3.36	0.49	3.03	3.02	3.03	3.41	29.50
1895	3.00	1.03	2.71	3.88	3.12	2.29	3.48	3.36	2.46	6.50	5.93	3.16	40.92
1896	1.93	5.61	6.45	1.00	2.02	1.78	2.52	3.40	5.88	2.85	2.52	1.87	37.83
1897	4.19	2.88	3.73	1.88	4.48	5.12	4.45	3.98	2.07	1.00	6.60	5.45	45.83
1898	5.84	4.57	1.47	4.74	2.92	3.25	5.04	6.56	1.81	6.57	5.32	3.05	51.14
1899	3.51	3.15	7.67	2.02	1.91	4.01	3.01	2.25	4.45	1.92	1.87	1.35	37.12
1900	4.46	8.19	6.73	1.80	3.06	1.90	1.49	4.11	3.63	2.76	5.50	2.96	46.59
1901	2.02	0.91	4.42	8.02	6.05	1.66	2.91	3.30	2.02	3.13	1.70	7.61	43.75
1902	2.15	4.27	5.32	5.54	3.08	2.05	3.33	7.12	4.17	5.96	0.77	6.16	49.92
1903	3.05	4.18	5.29	2.92	0.63	7.69	2.90	2.84	2.82	4.56	1.92	3.00	41.80
1904	4.14	1.99	2.75	8.15	2.95	2.39	1.85	4.52	4.18	0.94	1.45	2.31	37.62
1905	4.99	1.57	3.43	2.35	0.82	5.01	1.31	4.19	4.86	1.05	1.42	1.05	35.05
1906	2.35	2.51	5.29	2.75	7.22	5.83	3.98	2.46	0.84	2.24	2.69	4.05	42.21
1907	1.99	1.87	1.80	2.47	2.16	2.40	4.68	1.46	8.42	4.04	5.06	4.26	40.61
1908	2.82	4.80	2.61	1.96	4.23	0.96	4.30	7.42	0.63	1.92	0.97	2.87	35.49
1909	3.52	5.44	2.84	4.36	1.69	1.80	2.17	2.50	3.71	1.32	2.29	4.24	35.88
1910	4.49	6.12	1.27	2.44	1.38	3.48	2.11	2.37	2.06	1.34	3.05	1.84	31.95
1911	2.14	2.71	3.97	1.93	1.47	1.92	5.26	5.17	2.40	3.66	3.72	3.26	37.61
1912	3.29	2.31	5.69	3.41	4.05	0.26	5.43	2.34	1.49	1.77	3.08	3.82	36.94
1913	2.03	2.70	5.00	2.68	3.69	0.73	1.31	3.59	3.49	7.10	2.29	2.96	37.57
Av.	3.65	3.76	3.94	3.08	3.24	2.79	3.36	3.86	3.21	3.30	3.20	3.64	41.03

RAINFALL AT NEWTON, N. H. Elevation, 200 feet.

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1890	2.58	3.51	5.61	1.43	6.09	3.06	4.07	4.24	3.14	7.99	1.40	4.23	47.35
1891	6.39	3.74	3.96	2.44	2.54	4.28	2.70	2.23	1.05	3.55	1.91	3.16	37.95
1892	4.35	1.86	1.42	0.56	5.14	3.94	2.11	4.29	2.06	1.33	4.82	1.08	32.96
1893	1.71	4.63	2.07	2.70	6.50	2.42	2.98	4.75	1.58	4.63	1.81	4.87	40.65
1894	2.07	1.61	0.96	1.58	4.10	0.53	3.68	0.62	4.90	5.39	2.83	2.38	30.65
1895	3.05	0.25	2.44	3.60	1.49	1.65	5.44	2.69	2.81	7.45	6.11	2.32	39.30
1896	1.62	5.84	4.44	1.32	2.27	1.62	3.71	2.37	7.09	3.28	3.22	1.48	38.26
1897	4.05	2.22	3.81	1.95	4.59	6.61	4.22	3.33	3.16	0.15	6.96	4.66	45.71
1898	6.12	3.61	1.15	5.97	4.22	3.46	1.68	6.36	2.37	7.63	5.53	2.84	50.94
1899	3.11	2.61	6.66	1.90	1.25	2.45	3.82	1.67	4.83	1.98	2.40	1.68	34.36
1900	5.70	9.80	6.79	1.54	3.74	0.82	1.88	2.98	5.81	4.00	5.13	2.06	50.25
1901	1.33	0.58	5.43	9.40	6.31	1.39	3.25	2.99	4.06	2.90	2.80	7.29	47.73
1902	1.99	5.29	5.00	5.52	2.30	3.29	3.68	4.09	3.62	5.24	0.86	4.48	45.36
1903	3.63	3.03	5.99	3.50	0.74	9.60	2.87	3.12	1.52	4.06	1.59	2.70	42.35
1904	4.13	2.33	2.40	8.59	3.29	3.21	1.69	2.98	5.62	1.25	1.61	1.95	39.05
1905	4.85	1.65	2.42	2.59	1.37	4.55	2.42	2.95	5.77	1.15	2.42	3.66	35.80
1906	2.52	1.62	4.67	3.14	6.59	5.61	5.43	1.45	0.95	1.89	3.56	4.47	41.90
1907	2.24	2.06	1.60	2.95	1.78	3.84	3.41	1.18	7.85	3.79	5.72	3.76	40.18
1908	3.30	4.31	2.40	2.28	4.44	0.77	3.38	5.62	0.81	4.15	1.13	2.62	35.21
1909	3.61	4.89	3.66	4.25	1.57	1.21	2.49	3.38	4.88	1.02	3.12	3.56	37.64
1910	4.20	4.69	1.39	2.25	1.79	4.48	1.67	2.47	1.83	2.04	2.76	1.91	31.48
1911	2.19	2.67	4.05	1.53	0.68	2.40	4.27	4.41	2.14	2.92	4.10	3.73	35.09
1912	2.55	2.23	5.46	3.45	3.96	0.12	4.87	2.51	2.90	1.84	3.30	3.84	37.03
1913	2.10	3.06	4.63	3.22	3.27	0.28	1.09	2.49	2.28	9.15	2.01	3.43	37.01
Av.	3.31	3.25	3.69	3.24	3.34	2.98	3.20	3.13	3.46	3.70	3.21	3.26	39.77

RAINFALL AT NORTH CONWAY, N. H. Elevation, 575 feet.

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1888	4.88	4.57	5.54	2.47	3.22	2.90	2.16	3.87	5.40	8.48	6.32	3.56	53.37
1889	5.10	2.71	1.42	2.45	2.06	3.74	6.02	3.02	3.43	4.97	5.42	5.46	45.80
1890	3.07	3.96	2.76	1.99	5.32	4.21	4.72	6.05	5.24	5.60	1.72	5.98	50.62
1891	6.31	4.02	6.22	3.16	1.93	2.29	5.39	5.09	0.86	2.44	1.56	6.60	45.87
1892	5.72	1.94	2.37	0.44	5.16	5.62	1.54	4.27	3.83	1.79	4.33	0.65	37.66
1893	3.12	7.51	2.84	2.55	5.96	1.71	1.00	6.04	2.95	4.50	1.60	2.86	42.64
1894	1.20	3.00	2.43	1.10	5.95	2.35	2.53	2.35	5.00	3.64	2.20	3.60	35.35
1895	2.00	1.10	0.80	10.08	2.85	2.35	2.25	2.68	2.25	1.90	6.23	6.88	41.37
1896	0.85	6.00	9.86	1.46	3.35	2.40	2.75	3.60	5.97	4.18	5.30	1.90	47.62
1897	5.24	4.08	4.12	2.43	6.55	5.27	7.89	2.30	1.45	1.30	5.80	4.49	50.92
1898	6.00	6.33	0.30	2.45	2.55	3.60	1.27	0.70	3.35	5.64	3.72	3.05	38.96
1899	3.25	3.02	5.60	0.75	1.28	1.65	4.25	2.35	3.00	1.90	2.40	3.10	32.55
1900	5.75	9.42	8.01	0.90	3.00	2.80	1.90	2.60	1.78	2.12	7.70	2.06	48.04
Av.	4.04	4.44	4.02	2.48	3.78	3.14	3.36	3.46	3.42	3.73	4.18	3.86	43.91

RAINFALL AT PETERBORO, N. H. Elevation, 744 feet.

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1892	**4.41**	**2.42**	2.29	0.45	6.39	4.72	3 01	7 09	1.63	0.60	5.22	0 95	39.18
1893	2.52	6.43	2.37	**2.49**	**4.80**	**2.20**	1.71	6 16	1.86	3.95	1.77	5.73	41.99
1894	2.58	3.34	0.64	3.17	3.77	2.90	3.27	2.29	5.11	3.82	2.59	2.93	36 41
1895	3.04	1.30	2.19	4 40	2 31	2.64	4.70	2.67	2.99	6.52	6.10	3.58	42.44
1896	1.39	4.94	8.35	0.65	2.08	1.59	3 27	1.84	5.31	4.24	2.40	1.33	37.39
1897	3.35	3.23	3.33	2.08	4.03	7.21	9 28	2.77	1.66	0.64	6.12	5.48	49 18
1898	6.82	4.09	0.57	3.93	4.59	3.69	1 61	6.05	2.99	7.09	6.22	3.82	51.47
1899	2.26	3.67	7.09	2.06	1.41	3.97	4.40	2.57	5.19	2.09	2.16	1.74	38.61
1900	4 68	8.13	5.85	1.83	2.82	2.51	2 21	4.35	4.15	3.47	7.12	3.10	50.22
1901	2.10	1.01	5.07	9.35	5.65	1.16	4.20	6.36	2.36	3.74	1.98	7.94	50 92
1902	2.74	3.69	4.95	6.21	2.52	3 15	3.85	4.64	4.52	4.88	0.99	7 09	49.23
Av.	3.26	3.84	3.88	3.33	3.67	3.25	3.78	4.25	3.44	3.73	3.88	3.97	41.28

RAINFALL AT PLYMOUTH, N. H. Elevation, 500 feet.

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1888	4 17	5.09	7.19	3.59	3.97	3 17	1.58	3.91	8.06	5.18	5.28	2.28	53.47
1889	4.29	2.86	2.24	1.60	2.21	4 61	4.67	3.17	4.63	4.14	4.66	5.09	44.17
1890	3.85	4.82	4.41	2.19	6.24	2.95	4.46	5.60	5.63	4.93	2.05	3.94	51.07
1891	6.09	3.35	3.85	2.31	2.28	2.86	5.58	5.29	1.23	1.66	3.26	5.45	43.21
1892	5 01	1.93	1.67	1.04	5.53	6 76	1.66	10.85	1.10	1.90	4.29	0.95	42.69
1893	2.48	5.73	2.78	2.42	2.94	1.92	2.27	6 01	1.92	5.46	2.57	4.02	40.52
1894	2.01	2.75	1.84	1.67	4.36	3.70	2.43	3.12	4.32	3.83	2.27	1.88	34.18
1895	2.47	0.30	1.66	7.21	2.46	3.75	3.12	3.99	3.53	2.00	5.26	5.52	41 27
1896	0.39	5.51	7.83	0 94	1 69	1.34	2.92	3.61	5.55	5.09	5 26	1.07	41.20
1897	3.27	2.79	3.49	1.60	4.57	5.49	6.77	2.53	0.92	1.87	5.17	4.80	43.27
1898	5.38	3.56	1.26	2.83	2.90	2.92	2.31	5.29	4.47	3.98	3.64	1.72	40.26
1899	2.83	2.06	5.70	1.77	1.17	2.74	3.44	2.87	3.09	1.78	1.54	1.78	30.77
1900	4.86	6.44	4.75	0.65	1.72	2.44	3.22	2 42	1.61	3.94	6 15	0.97	39.17
1901	1.52	0.42	4.30	4.48	5.94	1.75	6.79	4.37	2.42	1.37	1.77	6.20	41.33
1902	2.27	1.83	4.37	3.41	3.02	4.52	3.20	3.86	5.72	4.27	1.16	5.22	42.85
1903	3.92	3.14	5.29	1.33	0.15	6.34	4.44	3.28	0.73	3.94	1.50	2.53	36.59
1904	2.05	1.32	2.84	5.58	5.14	2.26	4.14	4 18	6.40	3.04	0.84	1.36	39.15
1905	3.30	1.52	2.86	1.83	1.66	4.66	4.04	4.80	8.76	2.17	2.51	3.22	41.33
1906	2.42	2.32	3 15	2.38	5.27	3.87	3.64	1.59	1.50	4.03	1.94	2.68	34.79
1907	2.03	1.24	2.85	3.60	2.84	3.24	2.91	1.35	7.14	5.36	4.26	3 88	40.70
1908	2.05	3.21	1.67	2.81	5.46	0.68	5.18	4.57	0.94	1.07	1.25	2.95	31.84
1909	3.98	4.90	2.82	2.98	3.04	2.86	2.69	1.60	3.70	1.62	2.49	1.58	34.26
1910	4 05	3.77	1.10	4.11	3.41	3.65	1.91	3.79	5.08	1.48	2.28	2.64	37.27
1911	2.43	2 67	3.83	1.31	0 76	2.91	4.36	2.53	5.25	4.51	3.15	2.88	36.59
1912	2.41	1.71	4.20	3.01	4.69	1.11	3.21	5.38	3.16	3.91	3.51	3.47	39.80
1913	3.24	2.19	6.11	1.54	3.73	0.99	2.85	1.65	2.91	4.59	2.46	2 91	35.17
Av.	3.18	2.98	3.62	2.62	3.35	3.21	3.61	3.91	3.84	3.35	3.10	3.11	39.88

RAINFALL AT SANBORNTON, N. H. Elevation, 830 feet.

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1893	2.41	3.42	2.23	1.78	4.41	2.41	2.18	3.81	2.28	5.07	1.56	3.03	34.59
1894	1.82	1.62	1.17	1.69	4.58	1.83	2.68	2.42	3.45	3.05	1.27	1.83	27.41
1895	1.96	0.32	1.28	5.34	3.86	2.38	3.82	4.40	3.33	2.62	5.58	3.30	38.19
1896	0.55	3.81	6.41	1.02	2.83	3.04	3.41	4.04	5.01	5.36	4.01	0.84	40.33
1897	3.30	2.13	3.24	2.55	4.91	7.89	8.55	2.79	1.32	1.25	5.65	4.67	48.25
1898	4.74	3.04	0.79	3.25	3.40	4.08	2.97	3.91	4.35	5.19	4.30	2.97	42.99
1899	2.32	2.89	6.30	1.54	1.22	1.97	5.94	1.60	3.14	1.51	2.02	1.43	31.88
1900	5.25	7.24	5.36	1.27	2.10	1.74	2.23	2.57	3.54	2.91	5.28	1.87	41.36
1901	1.52	0.60	3.00	3.36	6.27	1.96	4.81	4.85	3.17	3.82	1.53	5.93	40.82
1902	2.49	1.78	4.68	3.83	2.78	4.17	4.11	6.14	5.11	4.13	1.30	5.43	45.95
Av.	2.64	2.68	3.45	2.56	3.64	3.15	4.07	3.65	3.47	3.49	3.25	3.13	39.18

RAINFALL AT STRATFORD, N. H. Elevation, 1 000 feet.

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1858	...	...	...	3.21	3.67	2.95	4.36	4.20	4.93	5.72	2.84	2.60	....
1859	1.81	1.28	4.63	1.93	1.87	6.18	2.59	1.99	4.29	1.40	3.02	4.33	35.32
1860	1.22	1.59	2.62	1.18	1.01	3.22	3.77	4.53	2.71	3.13	3.22	2.70	30.90
1861	2.75	2.90	5.27	3.41	5.10	3.94	4.47	4.29	3.79	5.54	1.56	2.08	45.10
1862	4.09	4.40	3.70	3.08	1.48	2.03	2.27	4.07	3.91	3.36	4.97	2.62	39.98
1863	5.45	2.34	3.65	2.31	3.67	2.70	8.97	3.04	2.88	3.98	2.76	3.75	45.50
1864	3.50	2.34	1.58	1.30	4.75	1.29	3.05	5.75	5.11	4.09	3.78	5.19	41.73
1865	3.00	2.32	4.69	3.54	4.48	3.23	5.42	1.68	1.51	2.42	3.11	3 11	38.51
1866	3.00	3.00	3.39	2.32	3.73	4.87	6.08	5.00	6.78	4.17	4.62	2.89	50.45
1867	1.45	2.30	6.98	4.07	6.23	2 03	4.76	5.46	0 60	3.46	1.51	2.15	41.00
1868	2.20	2.00	2.25	2.95	3.84	2.30	3.05	2.42	6.17	1.29	6.88	2.45	37.80
1869	2.98	5.40	3.60	2.63	3.97	4.39	2.36	3.17	3.39	8.49	2.93	4.58	47.89
1870	4.36	5.19	2.44	2.22	2.48	1.63	2.47	3.86	1.45	4.47	5.48	1.70	37.75
1871	2.25	2.72	4.34	4.60	2.94	1.62	3.29	5.15	1.30	4.80	2.08	2.91	38.00
1872	1.05	2.36	4.65	1.54	5.44	4.40	5.95	9.62	4.11	3.11	4.88	3.50	50.61
1873	3.58	2.40	4.26	1.83	2.08	1.79	3.51	1.73	4.94	6.58	3.54	2.57	38.81
1886	...	...	...	...	...	...	2.85	4.21	3.65	1 46	5.21	2.76	...
1887	3.22	3.04	1.46	3.10	2.00	4.82	7.10	2.23	2.12	2.87	2.09	4.33	38.38
1888	1.89	2.13	3.85	0.94	2.86	2.93	1.75	6.00	5.30	3.44	5.54	2.30	38.93
1889	1.77	0.77	2.48	0.98	2.24	5.03	4.00	1.81	6.52	2.96	3.66	3 92	36.14
1890	3.33	2.89	3.06	1.47	7.00	3.88	3.04	6.46	3.18	3.19	3.30	2.90	43.70
1891	4.65	2.18	2.04	1.84	2.68	1.79	4.88	2.75	1.43	0.92	2.62	3.46	31.24
1892	4.20	0.70	1.51	0.90	2.63	8.86	5.40	6.93	1.96	2.17	2.83	1.33	39.42
1893	0.87	3.21	2.45	1.82	2.67	2.86	2.89	2.31	2.18	2.37	1.11	3.04	27.78
1894	2.56	1.28	1.44	2.41	3.00	3.37	3.33	2.15	3.58	2.70	1.96	1.70	29.48
1895	0.76	0.63	1.18	4.31	3.62	4.47	3.43	4.40	2.19	2.09	5.64	3.40	36.12
1896	0.67	3.48	4.52	1.21	2.38	2.79	5.95	3.19	4.01	3.39	3.60	0.96	36.15
1897	2.23	1.46	2.84	2.90	4.92	5.80	10.00	2.88	2.36	1.37	5.75	3.41	45.92
1898	3.12	2.28	1.50	2.13	2.10	3.97	2.46	5.53	6.27	3.40	2.29	1.37	36.42
1899	2.08	2.90	3.57	0.65	1.38	2.62	4.10	0.67	2.30	1.57	1.93	2.08	25.85
1900	3.03	5.11	2.89	0.85	4.28	3.11	4.78	3.49	4.33	5.07	5.82	1.87	44.63
1901	2.34	0 88	3.21	2.42	3.62	4.33	4.40	3.20	2.74	2.47	1.93	4.42	35.96
1902	1.08	1.60	3.79	2.74	5.43	5.04	3.14	5.16	5.22	4.06	1.87	3.63	42.76
1903	2.38	2.84	3.98	1.12	0.18	3.18	3.27	2.70	0.52	2.30	1.11	1.79	25.37
1904	1.16	1.36	2.65	3.20	4.14	1 60	4.20	4.21	6.40	1.89	0.98	1.31	33.10
1905	2.05	0.85	2.14	1.82	2.73	3 30	4.80	5.60	4.30	0.57	2.44	3.23	33.83

RAINFALL AT STRATFORD, N. H. — *Continued.*

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1906	...	...	...	...	...	...	...	3.44	3.43	3.87	1.41	1.90	....
1907	1.85	0.82	2.27	2.43	1.73	8.54	6.26	1.92	5.80	4.97	2.42	3.46	42.47
1908	1.67	2.00	2.13	2.10	3.74	3.97	4.63	5.12	0.89	1.50	1.69	2.40	31.84
Av.	2.49	2.36	3.14	2.23	3.29	3.66	4.35	3.90	3.51	3.21	3.19	2.86	38.19

RAINFALL AT WEIRS, N. H. Elevation, 500 feet.

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1857	2.02	3.56	2 63	6.26	6.55	3.42	3.38	7.11	1.88	5.29	2.75	4.23	49.08
1858	3.25	1.97	1.76	3.20	3.22	2.38	4.67	4.14	5.05	6.98	2.35	3.58	42.55
1859	5.94	3.02	7.16	3.22	2.20	5.63	2.75	1.71	4.33	2.11	3.87	4.74	46.68
1860	0.70	3.62	2.09	1.35	1.94	3.86	5.05	4.24	4.63	3.28	5.74	3.93	40.43
1861	4.97	2.53	2.69	2 86	4.15	2.09	3.70	1.86	3.71	5.19	4.99	2.72	41.46
1862	6.37	3.97	4.99	2.05	2.57	4.41	3.19	4.67	3.65	4.42	6.08	2.90	49.27
1863	5.24	3.72	5.60	4.20	2.42	1.39	8.16	4.56	2.93	3.74	4.98	5.41	52.35
1864	2.83	1.77	4.01	3.41	2.86	0.51	0.98	4.73	2.89	3.97	5.63	4.64	38.23
1865	4.52	2.26	4.19	4.87	5.35	2.02	4.44	2 40	2.15	3.89	2.14	3.56	41.79
1866	1.80	4 71	3.06	1.57	3.47	3.45	3.75	3.62	5.84	2.40	3.29	3.11	40.07
1867	1.09	3.65	2.98	4.89	4.34	3.74	2.82	6.97	1.18	3.73	2.23	2.13	39.75
1868	2.97	1.12	1.09	2.67	8.16	2.02	4.11	2.99	10.18	0.49	6.47	2.05	44.32
1869	3.05	6.68	5.79	2.49	3.71	2.28	2.94	2.71	3.12	11.80	2.04	4.94	51.55
1870	6.23	6.27	4.89	6.39	1.38	1.77	3.39	1.58	1.40	3.96	3.18	1.80	42.24
1871	1.85	2.47	3.84	3.39	4.31	2.41	3.93	3.45	1.83	4.10	4.82	3.57	39.97
1872	1.74	3.76	2.77	1.75	3.28	5.83	2.82	8.22	6.89	2 28	4.89	3.19	47.42
1873	4.73	2.20	3.88	0.56	0.83	1.95	8.22	1.09	5.22	6.64	3.37	3.20	41.89
1874	2.34	3.70	0.84	2.61	4.50	4.00	7.98	2.43	5.62	1.78	3.30	1.29	40.39
1875	3.76	4.90	4.04	2.68	2.85	5.16	2.42	6.62	2.71	6.21	4.22	1.30	46.87
1876	2.94	5.67	9.76	2.77	2.34	5.05	5.52	0.36	4.31	0.97	2.85	3.70	46 24
1877	2.40	0.33	5.11	2.96	1.93	2.86	4.90	4.08	1.20	6.57	7.26	1.45	41.05
1878	4.50	1.88	2.50	5.67	0.99	5.76	2.57	4.23	1.35	4.48	5.48	7.38	46.79
1879	2.89	3.33	5.82	2.62	1.46	6.15	3.39	4.37	3.38	1.11	4.12	3.93	42.57
1880	5.23	2.47	1.66	2.68	2.97	2.65	3.28	1.55	2.52	4.67	3.65	2.99	36.32
1881	4.17	3.23	4.76	1.43	3.99	2.76	5.59	3.39	3.13	4.08	3.61	5.76	45.90
1882	3.74	2.85	3.20	1.34	4.77	4.72	1.92	0 55	8.09	1.43	0.74	2.74	36.09
1883	1.97	3.98	1.41	2.63	3.21	3.27	5.87	1.62	3.34	4.69	2.59	3.11	37.69
1884	2.80	4.87	4.63	3.33	2.94	0.80	4.94	4.08	0.95	2.42	3.14	3.67	38.57
1885	4.47	3.63	1.42	2.49	2.00	3.02	4.15	7.42	1.48	2.37	4.58	4.74	41.77
1886	3.93	4.49	3.19	1.54	2.72	2.38	4.47	3.54	4.17	3.58	4.63	4.26	42.90
1887	3.58	5.35	3.18	2.50	1.99	5.90	5.48	3.69	1.28	1.27	3.64	4.67	42.53
1888	4 32	4.31	2.79	3.39	4.44	2.07	1.13	4.11	9.31	5.66	5.68	2.34	49.55
1889	4.24	2.06	2.69	1.91	2.42	4.21	3.23	1.71	5.11	3.87	4.71	4.41	40.57
1890	4.07	4.12	4.90	2.28	6.34	2.37	4.76	5.60	6.91	4.32	1.60	4.87	52.14
1891	6.74	3.94	4.40	1.76	2.66	3.49	5.23	4.07	0.96	2.29	2.20	4.34	42.08
1892	3.80	1.48	1.38	0.90	6 04	6.27	2.16	9 31	2.45	1.40	4.17	0.93	40.29
1893	2.89	6.07	2.90	2.23	4.13	2.41	1.61	4.01	2.36	5.20	1.63	3.98	39 42
1894	3.19	4.16	2.11	1.00	4.54	2.45	2.31	3.03	2.47	2.48	1.52	1.75	31.01
1895	3.96	1.19	2.03	5.36	1.98	3.20	3.50	3 94	3.25	3.32	4.78	3.78	40.29
1896	0.56	4.24	7.61	1.08	2.80	1.63	3 41	2.73	5.46	5.44	3 88	1.02	39.89
Av.	3.55	3.49	3.64	2.81	3.37	3.29	3.95	3.81	3.72	3.85	3.82	3.45	42.75

RAINFALL AT WEST MILAN, N. H. Elevation, 1 016 feet.

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1887	5.09	4.36	1.92	3.14	1.60	5.10	6.92	3.00	1.29	1.64	3.03	4.51	41.60
1888	4.40	1.42	3.54	1.41	2.09	1.80	2.18	5.54	4.63	4.68	5.85	2.47	40.01
1889	3.12	1.80	2.06	1.29	1.14	4.87	4.64	1.54	4.66	3.35	4.07	3.71	36.25
1890	4.66	1.97	3.90	1.14	5.91	6.46	3.08	7.06	3.21	3.68	3.66	3.76	48.49
1891	4.86	3.64	3.70	2.92	2.17	2.33	4.79	2.64	1.71	1.64	2.67	4.30	37.37
1892	4.57	2.05	2.26	0.69	3.19	8.74	3.66	8.38	2.74	1.88	4.91	1.55	44.62
1893	1.86	4.78	2.89	2.70	3.30	3.12	2.36	4.46	2.93	3.26	1.80	3.05	36.51
1894	3.35	4.95	2.30	2.05	3.37	4.58	3.47	1.91	2.87	2.54	3.44	3.67	38.50
1895	2.93	1.42	1.47	3.87	3.76	4.01	2.82	3.67	1.97	1.56	5.64	3.96	37.08
1896	2.30	7.83	4.38	2.66	2.23	2.52	4.34	3.50	3.74	2.52	3.38	1.37	40.77
1897	2.95	2.20	3.57	2.95	4.60	6.97	5.56	2.44	2.40	1.21	5.51	3.12	43.48
1898	4.25	4.82	...	...	...	...	...	...	...	...	...	...	...
Av.	3.65	3.31	2.91	2.26	3.03	4.59	3.98	4.01	2.92	2.54	4.00	3.23	40.43

RAINFALL AT WOLFBORO, N. H. Elevation, 500 feet.

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1877	1.97	0.42	5.38	3.60	2.27	2.52	5.20	5.07	0.63	5.59	6.86	1.14	40.65
1878	4.20	2.30	2.28	5.01	0.58	4.03	2.18	2.37	1.32	3.85	4.64	6.90	39.66
1879	1.08	3.43	1.96	2.73	0.65	6.19	3.90	3.81	3.75	0.86	3.58	4.33	36.27
1880	2.74	2.67	1.39	2.80	2.72	2.81	3.42	2.29	2.97	4.33	3.21	1.99	33.34
1881	5.28	3.19	3.69	1.36	4.32	3.19	5.07	1.22	3.21	3.35	2.59	5.30	41.77
1882	4.16	5.19	3.11	1.16	3.89	3.80	2.38	0.47	7.42	1.20	0.70	2.46	35.94
1883	2.41	4.08	1.54	2.60	4.16	5.32	6.92	1.68	2.42	4.24	2.42	3.27	41.06
1884	4.71	5.64	5.48	3.52	3.37	1.69	3.89	4.01	1.28	2.63	3.47	5.05	44.74
1885	4.58	5.63	1.63	2.61	2.09	4.48	5.23	7.68	0.99	3.23	6.49	4.83	49.47
1886	4.99	5.40	2.28	2.20	3.18	2.70	3.21	3.19	4.63	3.00	5.10	5.00	44.88
1887	5.19	5.63	4.69	4.45	1.92	4.78	6.09	4.40	2.18	2.10	4.22	5.47	51.12
1888	4.48	5.04	7.27	3.21	3.75	2.46	1.45	3.99	8.07	6.13	5.69	3.33	54.87
1889	5.76	2.13	3.06	2.33	1.95	3.22	5.11	1.13	3.86	3.81	6.57	2.98	41.91
1890	3.20	4.31	5.09	1.57	6.77	3.81	4.72	4.54	5.98	7.20	1.99	3.92	53.10
1891	6.44	4.22	4.16	2.59	2.21	1.87	5.85	3.76	1.18	3.67	1.56	5.11	42.62
1892	3.00	1.55	1.64	1.04	4.87	5.58	2.46	6.25	2.79	1.64	3.77	0.63	35.22
1893	1.04	3.19	1.79	1.73	4.17	1.93	2.24	3.10	1.68	5.19	1.63	3.95	31.64
1894	2.02	2.02	1.33	1.63	4.53	2.60	2.34	4.01	3.13	2.53	1.16	1.59	28.89
1895	2.34	0.15	1.88	5.59	2.63	1.50	3.55	4.80	3.81	2.05	5.64	3.50	37.44
1896	0.58	5.93	6.10	0.90	3.09	1.92	2.72	2.27	5.39	5.14	3.97	0.95	38.96
Av.	3.51	3.61	3.29	2.63	3.16	3.32	3.90	3.50	3.33	3.59	3.76	3.58	41.18

RAINFALL AT WOODSTOCK, N. H. Elevation, 1 000 feet.

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1885	5.32	3.20	2.35	1.88	1.68	5.43	5.07	12.92	2.60	4.25	5.05	5.05	54.80
1886	4.71	4.19	4.13	1.55	3.48	2.30	3.45	3.87	4.07	3.01	6.13	4.25	45.14
1887	6.90	7.35	2.52	3.45	6.20	6.73	6.70	4.83	1.70	2.80	3.31	4.71	57.20
Av.	5.64	4.91	3.00	2.30	3.79	4.82	5.07	7.21	2.79	3.35	4.83	4.67	52.38

VERMONT.

RAINFALL AT BLOOMFIELD, VT. Elevation, 900 feet.

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1906	...	...	...	...	...	...	...	3.44	3.43	3.87	1.41	1.90	....
1907	1.85	0.82	2.27	2.43	1.73	8.54	6.26	1.92	5.80	4.97	2.42	3.46	42.47
1908	1.67	2.00	2.13	2.10	3.74	3.97	4.63	5.12	0.89	1.50	1.69	2.40	31.84
1909	4.11	4.02	1.79	4.50	4.39	2.40	3.25	2.05	5.57	1.68	1.79	0.93	36.48
1910	3.14	2.73	1.28	3.58	4.94	3.74	4.17	3.72	3.47	2.07	1.44	1.74	36.02
1911	1.43	1.50	3.21	1.22	1.08	3.39	4.53	5.49	3.89	2.75	2.10	3.18	33.77
1912	1.63	1.42	2.85	2.77	5.74	3.43	2.56	5.16	5.24	1.77	2.93	2.43	37.93
1913	3.19	1.33	5.58	1.83	3.13	1.82	4.74	3.28	2.48	4.97	1.19	1.91	35.45
Av.	2.43	1.97	2.73	2.63	3.54	3.90	4.30	3.82	3.91	2.82	1.94	2.29	36.28

RAINFALL AT BRATTLEBORO, VT. Elevation, 335 feet.

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1885	**5.26**	**3.39**	0.77	3.13	2.92	2.46	2.40	6.34	1.36	4.74	5.64	2.75	41.16
1886	6.47	3.14	2.98	3.29	3.71	2.25	4.33	3.29	4.25	4.14	5.67	4.29	47.81
1887	6.58	5.60	3.63	2.50	1.88	4.20	5.44	7.68	0.95	2.46	3.42	5.28	49.62
1888	4.35	4.33	7.46	3.96	3.56	2.70	1.43	4.82	11.56	6.12	5.65	3.21	59.15
1889	5.30	1.74	1.24	2.39	2.30	4.01	8.20	4.04	3.87	4.44	7.29	4.19	49.01
1890	3.10	4.98	5.11	1.47	5.00	2.77	3.17	7.93	6.18	7.64	1.56	4.16	53.07
1891	6.92	4.17	3.89	3.69	2.27	3.58	6.26	4.80	1.29	2.75	2.87	4.95	47.44
1892	4.13	2.22	1.96	0.45	4.81	3.02	2.37	6.29	1.91	0.66	2.83	0.93	31.58
1893	2.33	5.61	2.27	2.84	4.96	2.18	1.64	6.39	2.06	3.42	1.89	2.89	38.48
1894	1.85	2.29	1.06	1.37	2.62	1.54	1.90	0.32	4.21	3.83	2.25	3.00	26.24
1895	2.73	0.64	1.96	4.18	1.26	3.86	2.11	2.40	3.37	2.25	3.86	3.80	32.42
1896	2.21	3.56	5.89	1.53	1.79	1.33	2.77	2.22	3.90	2.37	2.46	0.85	30.88
1897	2.93	1.99	2.81	2.31	2.91	4.85	12.09	2.93	1.91	1.48	7.52	6.93	50.66
1898	5.99	4.94	1.05	4.13	5.19	4.47	1.76	4.84	2.54	10.84	6.20	2.56	54.51
1899	2.96	3.21	7.95	1.48	1.24	5.23	**2.12**	1.78	3.47	1.19	2.40	2.65	35.68
Av.	4.21	3.45	3.34	2.58	3.09	3.23	3.87	4.40	3.52	3.89	4.10	3.50	43.18

RAINFALL AT BURLINGTON, VT. Elevation, 404 feet.

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1828	1.30	2.10	1.35	2.75	2.45	3.70	5.95	4.30	9.85	1.65	6.25	1.65	43.30
1832	3.56	3.22	2.31	1.96	5.71	3.41	3.52	4.76	1.81	4.05	3.01	2.27	39.59
1833	1.26	2.53	1.48	1.28	9.85	4.28	7.54	7.34	4.17	6.01	1.91	1.79	49.44
1837	...	...	...	...	...	...	4.47	2.19	3.27	3.85	3.29	1.60	....
1838	2.52	1.32	1.10	1.34	4.51	5.37	3.25	2.41	1.33	2.98	3.78	0.92	30.83
1839	0.85	1.20	1.43	1.60	2.43	3.70	6.26	1.91	2.91	0.45	2.57	2.68	27.99
1840	1.26	2.19	3.05	4.69	2.46	2.84	4.18	3.51	4.71	3.76	2.22	2.41	37.28
1841	3.49	0.80	3.23	3.54	2.28	5.16	2.87	1.40	3.62	0.83	2.47	3.02	32.71
1842	1.04	3.75	1.97	2.52	1.55	3.21	4.62	1.74	3.80	4.10	2.32	3.20	33.85
1843	0.71	1.43	2.12	0.82	2.47	4.58	2.59	2.09	1.80	5.03	1.63	1.48	26.75
1844	2.29	0.73	2.35	1.43	4.40	2.08	5.35	3.46	1.36	5.11	0.57	2.08	31.21
1845	2.38	2.52	2.48	2.22	3.39	2.08	4.51	2.37	5.62	2.26	4.00	2.21	36.04
1846	1.72	1.47	2.20	0.91	3.18	3.63	5.08	0.48	3.78	2.65	2.88	1.68	29.66
1847	2.80	1.85	2.10	3.15	1.85	5.05	4.05	3.12	4.69	3.69	2.13	4.07	38.55
1848	1.84	0.90	2.44	1.09	4.24	2.19	3.57	4.40	2.91	2.59	2.26	2.95	31.38
1849	0.79	0.41	2.14	0.47	2.74	1.41	1.73	5.69	1.33	5.32	2.69	1.63	26.35
1850	1.57	1.79	1.11	2.41	5.04	3.18	3.08	0.89	3.25	8.11	1.77	3.31	37.51
1851	1.20	1.90	0.67	1.67	2.29	7.33	3.81	1.92	2.06	3.56	3.59	1.83	31.83
1852	1.03	1.69	1.92	1.15	0.71	4.76	4.99	1.50	1.80	4.11	2.90	2.26	28.82

RAINFALL AT BURLINGTON, VT. — *Continued.*

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1853	1.22	3.94	1.70	2.25	3.95	1.74	3.12	3.46	5.67	3.04	2.17	0.79	33.05
1854	1.82	1 65	1.69	3.60	1.62	2.88	1.60	0.61	4.44	2.26	2.17	1.11	25.45
1855	1.95	0.98	0.72	2.22	0.34	6.47	8.43	2.94	4.50	5.97	1.28	2.50	38.30
1856	0.96	0.18	0.51	1.36	2.83	1.67	1.67	9.13	3.43	2.28	1.79	1.01	26.82
1857	**2.60**	**2.90**	**4.50**	**3.00**	**2.80**	**3.25**	**3.50**	**3.00**	**2.95**	**4.18**	**2.50**	**2.07**	37.25
1858	1.64	**3.00**	**1.50**	1.82	2.68	2.27	4.65	2.12	2.51	2.62	2.40	**3.00**	30.21
1859	**1.07**	**2.05**	**4.25**	**1.25**	**2.75**	**4.00**	**2.25**	**3.06**	**4.50**	**2.50**	**2.85**	**4.77**	35.30
1860	3.00	1.25	1.63	0.62	1.60	1.25	4.28	5.28	4.84	3.63	5.24	1.26	33.88
1861	3.00	2.87	3.93	5.00	3.78	2.20	6.78	1.82	2.97	5.94	2.69	1.58	42.56
1862	2.46	3.20	4.16	1.18	0.76	2.00	4.30	7.48	3.38	3.84	2.50	1.48	37.74
1863	3.47	1.98	2.75	1.55	6.88	1.95	5.76	2.41	5.30	3.90	2.27	2.96	41.18
1864	1.48	0.80	2.20	2.55	3.13	1.51	2.85	5.86	5.49	4.67	3.10	2.40	36.04
1865	2.50	1.30	2.08	2.75	3.34	4.37	5.88	1.95	2.44	2.22	1.90	1.70	32.43
1866	1.50	2.02	1.38	2.42	2.92	5.47	4.83	6.47	5.95	1.65	2.65	2.00	39.26
1867	1.50	0.70	1.30	2.42	7.70	1.55	2.14	2.63	3.23	2.57	0.85	0.00	26.59
1868	1.50	0.50	1.00	1.00	5.09	2.74	2.31	1.35	4.92	1.41	5.69	1.50	29.01
1869	1.80	3.80	2.00	2.95	4.25	8.85	3.67	3.69	2.67	8.17	1.91	2.58	46.07
1870	2.72	3.83	1.50	1.60	1.06	3.13	3.15	3.46	3.88	3.51	2.32	1.50	31.66
1871	1.50	1.50	3.08	3.88	2.30	1.72	4.16	3.35	1.86	3.10	1.70	1.82	29.97
1872	0.42	0 19	0.13	0.73	2.69	3.63	5.27	9.62	3.43	3.05	2.75	1.34	33.25
1873	2.18	0.36	1.54	1.43	1.46	1.35	4.83	2.21	2.09	5.87	1.59	1.01	25.92
1874	3.44	0.82	1.34	3.19	4.21	3.85	7.15	1.07	4.21	1.09	0.82	0.75	31.94
1875	1.26	0.86	1.12	1.38	3.56	3.00	2.73	2.84	4.56	3.54	1.34	0.75	26.94
1876	1.60	1.31	3.11	2.38	2.30	2.91	2.49	2.66	4.82	0.92	1.51	1.52	27.53
1877	1.43	0.32	2.52	2.53	0.95	3.11	4.06	4.74	3.45	6.33	2.21	1.46	33.11
1878	7.52	0.79	1.65	3.06	3.05	2.49	5.18	5.18	1.13	4.78	3.38	3 24	41.45
1879	0.78	1.11	1.45	0.97	0.38	4.52	2.71	2.39	2.82	1.36	3.56	2.22	24.27
1880	1.87	0.62	0.97	1.73	1.46	1.33	2.30	2.26	3.26	6.22	2.57	0.62	25.26
1881	0.88	1.79	1.56	0.62	2.27	7.89	2.22	2.69	2.34	1.54	1.30	1.89	26.99
1882	0.44	1.10	2.34	1.23	2.00	3.17	2.37	3.49	5.22	1.21	1.47	1.60	25.64
1883	0.93	1.07	1.15	1.37	3.67	4.69	3.15	3.68	3.33	3.27	1.59	1.44	29.34
1884	2.14	2.68	2.89	1.92	3.60	1.36	2.95	3.24	3.22	3.82	2.95	2.60	33.37
1885	2.36	1.40	0.86	2.53	2.48	2.52	3.80	3.41	3.50	4.77	3.94	2.07	33.64
1886	1.68	1.06	1.33	1.68	2.61	1.98	3.94	3.22	3.73	1.25	4.29	1.70	28.47
1887	1.87	1.67	1.87	2.21	2 00	4.38	2.22	2.80	2.01	1.99	4 67	3.44	31.13
1888	1.06	0.79	3.71	1.93	3.26	3.95	1.47	4.10	5.68	3.94	3.60	1.63	35.12
1889	3.57	1.59	2.35	1.51	4.28	6.26	4.09	2.48	4.82	3.32	2.46	1.48	38.21
1890	2.05	1.98	2.11	1.93	6.12	2.57	3.33	6.76	3.84	2.02	2.31	1.90	36.92
1891	2.85	1.01	1.70	2.77	2.16	1.48	3.48	3.25	2.44	3.02	2.73	2.23	29.12
1892	2.76	1.67	0.92	1.02	4.28	6.72	7.66	8.36	3.22	1.35	3.28	1.00	42.24
1893	0.70	1.24	0.52	1.70	3.17	1.73	3.74	8.31	2.45	1.72	1.41	2.35	29.04
1894	1.30	0.99	1.31	0.86	3.54	1.45	1.57	1.49	2.88	3.59	1.96	2.02	22.96
1895	1.31	1.16	0.77	1.65	3.79	2.78	2.46	4.84	3 64	0.23	4.32	1.74	28.69
1896	0.63	1.94	3.54	0.60	1.25	3.13	3.83	4.09	3.59	2.52	2.43	0.83	28.38
1897	2.50	1.08	2.49	4.01	5.00	5.63	8.48	4.08	2.13	1.53	4.41	2.10	43.44
1898	2 60	2.98	1.04	2.33	2.14	2.93	1.51	4.58	5.01	4.01	1.90	0.75	31.78
1899	1.12	1.24	4.12	1.88	2.01	2.43	5.37	3.82	6.38	2.81	3.42	2.65	37.25
1900	3.32	2.17	3.19	0.91	2.45	1.96	2.73	5.25	3.20	1.90	5.74	1.42	34.24
1901	1.76	0.67	2.73	3.11	3.96	4.70	2.29	3.18	3.07	2.88	1.84	3.69	33.88
1902	0.66	1.82	2.82	2.37	4.46	5.29	6.23	3.17	3.68	4.95	1 29	1.62	38.36
1903	2.18	1.92	3.53	1.63	T	4.92	6.68	4 02	0.80	4.55	1.21	1.42	32.86

RAINFALL AT BURLINGTON, VT. — *Continued.*

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1904	1.36	0.90	1.00	3.06	2.99	2.37	4.19	2.56	5.84	3.29	0.52	1.63	29.71
1905	1.28	0.75	1.82	2.15	2.58	4.70	7.67	3.98	4.32	2.59	1.38	1.51	34.73
1906	1.00	2.02	1.75	1.29	2.83	5.28	2.33	2.26	3.59	2.93	2.60	1.99	29.87
1907	1.02	0.67	1.37	2.56	1.54	4.21	3.68	1.05	4.70	3.59	2.67	2.61	29.67
1908	1.54	2.27	1.74	1.93	3.47	2.46	2.66	1.70	1.15	1.95	1.03	1.59	23.49
1909	2.38	4.18	1.81	2.67	5.58	3.57	4.06	2.83	4.36	1.13	1.66	1.53	35.76
1910	2.70	3.00	0.51	2.10	3.42	3.10	3.06	2.76	2.75	3.34	2.43	2.46	31.63
1911	1.32	1.39	2.44	0.83	1.13	2.54	2.47	3.83	3.46	2.84	1.56	2.51	26.32
1912	0.86	1.94	2.97	2.97	5.55	1.18	3.24	2.55	5.26	2.95	3.51	1.15	34.13
1913	2.38	0.56	4.53	1.72	2.56	2.22	2.83	1.10	2.66	2.90	0.68	1.61	25.75
Av.	1.85	1.64	2.03	2.01	3.08	3.40	3.96	3.48	3.59	3.25	2.54	1.93	32.76

RAINFALL AT CAVENDISH, VT. Elevation, 910 feet.

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1903	...	0.62	4.28	1.04	0.33	8.24	4.26	3.64	1.20	2.94	1.02	2.88	....
1904	2.74	1.11	2.12	5.65	2.87	2.41	3.97	3.90	8.24	2.67	1.16	1.77	38.61
1905	2.66	1.62	1.63	1.40	1.92	5.04	5.98	3.50	6.60	1.74	1.87	2.31	36.27
1906	1.84	1.36	2.05	1.36	4.73	4.35	2.79	2.95	1.41	2.89	2.36	2.23	30.32
1907	1.05	0.83	1.45	2.19	3.06	2.38	3.37	1.11	6.71	4.80	3.89	3.18	34.02
1908	1.25	3.18	1.74	1.23	6.65	1.36	2.34	5.34	1.23	**1.33**	0.85	**2.71**	29.21
1909	3.46	4.02	2.01	2.36	3.13	3.98	2.05	3.83	4.45	1.31	2.07	2.63	35.30
1910	4.19	3.20	0.60	2.40	3.10	3.60	1.82	3.68	4.04	0.99	3.03	1.41	32.06
1911	1.38	2.38	3.19	1.04	0.47	3.36	4.62	2.93	4.86	5.01	**2.31**	2.60	34.15
1912	2.70	1.75	3.81	1.89	6.20	**0.99**	4.40	3.62	5.48	5.86	2.69	2.04	41.43
1913	2.58	1.87	5.90	1.63	4.03	0.58	2.83	**1.80**	2.75	5.39	**1.92**	**3.41**	34.69
Av.	2.38	2.13	2.45	2.12	3.62	2.80	3.42	3.27	4.58	3.20	2.21	2.43	34.61

RAINFALL AT CHELSEA, VT. Elevation, 840 feet.

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1886	3.66	2.82	2.02	1.74	2.88	2.29	2.46	3.59	3.46	2.28	5.10	2.06	34.36
1887	3.71	4.35	2.48	2.61	2.26	5.98	5.66	8.45	2.23	1.21	3.72	4.04	46.70
1888	3.32	2.19	3.27	2.94	3.76	5.22	2.74	3.78	5.39	3.87	4.28	2.92	43.68
1889	4.11	2.35	3.52	1.28	4.74	6.59	5.05	1.85	4.95	3.57	4.81	3.52	46.34
1890	3.80	3.85	2.93	2.68	5.35	3.11	2.49	7.20	4.54	4.09	2.25	3.32	45.61
1891	4.38	2.86	3.21	2.85	2.91	2.71	4.20	4.00	2.14	2.43	2.46	3.31	37.46
1892	4.28	1.85	2.21	1.25	5.71	5.85	2.59	6.28	1.75	2.05	3.79	1.24	38.85
1893	1.64	3.59	1.63	2.33	3.97	2.75	**6.00**	**2.40**	**3.60**	**2.60**	**1.70**	**2.50**	34.71
1894	**3.00**	**4.70**	**5.20**	**2.10**	**4.55**	**1.60**	**3.15**	**3.40**	**0.70**	**1.70**	**4.40**	**3.80**	38.30
1895	**4.40**	**2.00**	**1.80**	**2.29**	**2.00**	2.60	2.30	3.49	2.40	0.91	5.91	3.78	33.88
1896	0.94	4.56	5.44	0.28	1.06	1.78	3.96	2.33	4.27	2.21	3.03	0.68	30.54
1897	3.58	1.90	3.96	2.91	5.02	4.49	10.60	4.08	1.37	0.89	5.91	3.35	48.06
1898	4.66	4.78	0.97	2.65	3.34	2.24	2.28	4.71	3.98	3.84	2.82	1.26	37.53
1899	2.85	1.95	4.66	1.16	1.82	1.44	2.38	0.46	3.94	2.33	1.95	2.12	27.06
1900	3.50	4.20	3.73	1.13	1.95	2.01	3.31	4.55	2.12	3.19	5.44	1.35	36.48
1901	2.58	0.42	2.73	2.42	4.59	2.08	3.95	1.57	1.69	1.71	0.99	4.64	29.37
1902	2.20	1.96	5.15	3.83	3.84	4.03	3.86	2.92	2.93	3.68	0.50	3.87	38.77
1903	2.30	2.73	5.03	0.80	0.29	4.85	3.86	3.28	1.44	1.97	1.02	2.08	29.65

RAINFALL AT CHELSEA, VT. — *Continued.*

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1904	2.34	0.51	1.93	2.82	2.69	0.86	3.56	4.76	5.90	1.77	0.90	1.36	29.40
1905	1.50	1.20	1.93	2.14	1.33	3.40	4.57	4.45	5.26	1.10	1.80	1.80	30.48
1906	2.21	2.67	3.30	1.11	3.61	4.53	3.12	4.68	1.28	2.81	2.24	4.11	35.67
1907	1.84	1.27	1.27	5.37	2.53	3.93	2.80	2.00	8.18	5.75	3.20	3.52	41.66
1908	0.96	3.96	1.61	2.57	3.25	3.00	1.66	3.20	1.13	2.08	1.65	2.38	27.45
1909	3.65	6.02	1.60	2.86	3.47	3.36	2.08	2.96	3.22	0.41	**2.16**	1.31	33.10
1910	2.96	3.87	0.65	2.61	4.58	2.76	1.74	2.96	5.10	1.89	1.94	2.07	33.13
1911	1.73	2.21	2.91	0.87	0.44	2.94	1.31	5.51	3.89	4.22	1.55	2.56	33.14
1912	1.68	1.35	3.31	2.51	5.92	1.21	1.26	3.84	4.10	4.81	2.85	2.32	35.16
1913	3.26	0.97	6.33	1.93	2.81	1.80	2.93	0.83	1.74	4.64	2.15	2.51	31.90
Av.	2.89	2.75	3.03	2.22	3.24	3.19	3.53	3.70	3.31	2.64	2.88	2.64	36.02

RAINFALL AT CORNWALL, VT. Elevation, 507 feet.

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1887	3.32	2.28	3.32	2.19	**1.44**	4.30	4.44	3.68	1.60	1.29	4.76	3.37	35.99
1888	2.65	1.39	4.55	2.09	2.67	3.75	1.18	2.72	4.31	4.44	3.28	3.55	36.58
1889	3.59	1.20	3.24	1.08	3.97	5.07	5.60	1.41	3.50	3.36	3.88	2.30	38.20
1890	3.13	3.80	3.44	2.24	5.49	2.50	2.31	6.00	2.96	2.03	1.28	2.74	37.92
1891	3.60	2.25	1.91	1.94	2.40	3.60	3.98	4.36	2.25	**1.83**	2.33	1.95	32.40
1892	3.82	0.50	1.06	0.85	5.54	6.15	3.47	5.19	1.42	0.68	1.34	0.38	30.40
1893	1.63	2.84	1.12	1.25	1.99	1.83	3.59	7.06	1.57	0.93	1.00	3.21	28.02
1894	2.53	3.05	0.45	0.88	2.32	3.94	2.69	2.35	1.90	3.66	3.64	2.68	30.09
1895	1.45	1.40	0.90	2.05	4.10	2.10	2.80	5.88	2.17	1.15	4.88	2.05	30.93
1896	0.73	1.83	3.14	0.43	1.37	2.41	2.97	4.37	4.83	2.61	2.58	0.80	28.07
1897	2.22	1.04	2.01	3.50	4.26	4.92	8.71	3.23	1.65	1.58	5.41	3.41	41.94
1898	4.00	2.49	1.23	1.89	3.49	3.23	1.45	2.30	3.76	2.84	1.30	1.05	29.03
1899	1.20	2.28	3.45	1.15	1.70	1.60	4.28	0.38	6.23	2.57	2.48	3.24	30.56
1900	3.60	3.86	2.60	0.32	1.30	2.38	2.78	4.13	1.67	1.98	4.10	1.28	30.00
1901	1.79	0.92	1.17	3.15	4.10	2.91	4.61	3.27	1.36	2.03	2.93	**3.54**	31.78
1902	1.22	2.13	3.53	2.33	2.85	3.61	3.50	4.62	4.04	2.64	1.32	1.44	33.23
1903	2.28	2.73	3.79	1.08	0.24	4.20	5.16	3.45	0.90	3.05	2.10	0.85	29.83
1904	1.85	2.49	1.56	3.65	3.30	3.21	5.05	1.95	3.53	2.94	0.78	1.49	31.80
1905	0.96	1.00	2.42	2.67	1.88	6.05	4.06	3.34	5.50	2.55	2.06	2.06	34.55
1906	1.86	2.31	1.82	0.95	3.10	5.50	**2.33**	**2.26**	**3.59**	**2.93**	2.46	2.20	31.31
1907	1.35	0.85	0.37	2.90	0.83	**4.21**	**3.68**	**1.05**	**4.70**	3.39	**2.67**	**2.61**	28.61
1908	**1.54**	**2.27**	**1.74**	**1.93**	3.47	**2.46**	**2.66**	**1.70**	**1.15**	1.23	0.96	**1.59**	22.70
1909	2.62	3.77	1.70	1.93	5.74	3.03	2.79	3.28	3.24	0.94	1.54	1.27	31.85
1910	2.90	2.76	0.53	2.21	3.96	3.54	2.05	5.02	6.76	**3.34**	2.59	2.27	37.93
1911	1.29	2.70	2.30	0.78	1.57	3.00	2.80	3.68	2.57	4.21	1.10	2.85	28.85
1912	2.13	1.80	2.67	2.30	6.03	**1.18**	1.84	**2.55**	**5.26**	3.57	3.48	2.07	34.88
1913	2.15	0.97	4.29	**1.72**	**2.56**	**2.22**	**2.83**	1.23	2.25	5.72	0.87	3.19	30.00
Av.	2.28	2.11	2.23	1.83	3.02	3.44	3.47	3.35	3.14	2.57	2.49	2.20	32.13

RAINFALL AT ENOSBURG FALLS, VT. Elevation, 601 feet.

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1891	...	...	...	...	...	1.39	5.95	4.64	2.98	2.23	3.25	4.02	...
1892	3.54	2.00	2.74	2.10	4.49	11.23	5.78	7.63	1.43	2.56	4.09	2.40	49.99
1893	1.40	3.65	1.20	2.53	2.91	2.61	4.77	6.21	3.37	2.21	1.76	1.62	37.24
1894	2.45	2.35	2.40	1.86	4.96	3.19	5.51	3.09	3.70	5.26	2.29	1.91	38.97
1895	1.70	2.15	0.85	2.59	4.61	4.14	3.00	3.37	2.20	0.56	6.24	4.29	35.70
1896	1.30	5.57	6.26	1.75	2.42	4.13	4.10	2.84	2.42	3.31	3.58	0.45	38.13
1897	3.45	1.25	2.47	3.91	5.50	3.46	12.73	2.77	2.02	0.82	4.63	3.93	46.94
1898	4.56	4.40	1.20	1.58	2.70	3.45	2.29	5.53	4.89	3.62	1.90	4.23	40.35
1899	2.30	2.18	6.40	1.66	2.11	**2.43**	**5.37**	1.99	3.83	3.99	2.21	2.90	37.37
1900	3.30	3.65	3.93	2.19	4.23	4.21	5.02	3.41	3.03	3.54	7.54	4.24	48.29
1901	5.17	3.65	5.97	2.72	2.88	5.35	3.84	5.74	2.76	3.26	5.71	5.25	52.30
1902	2.97	5.46	4.81	3.08	4.96	5.64	5.10	2.85	3.28	5.51	2.59	2.40	48.65
1903	2.88	4.64	5.08	2.95	0.45	4.14	5.02	3.79	0.45	3.43	1.63	2.27	36.73
1904	2.88	1.81	2.46	2.43	3.21	4.46	4.82	4.22	5.45	3.04	0.75	1.71	37.24
1905	1.82	0.54	2.99	2.22	3.11	4.10	7.59	4.63	3.69	2.89	2.76	3.04	39.38
1906	2.05	2.11	1.99	2.09	3.26	6.16	4.03	1.49	3.79	2.91	3.33	2.46	35.67
1907	2.22	0.91	1.91	2.29	1.85	4.70	6.34	1.94	5.41	4.56	2.55	3.93	38.61
1908	1.78	2.89	2.71	2.43	6.26	2.79	2.51	2.50	1.16	2.47	1.86	2.54	31.90
1909	4.26	3.98	1.67	3.89	5.00	2.43	3.10	3.26	4.73	1.49	3.33	1.51	38.65
1910	2.08	3.54	1.56	3.10	4.09	3.68	2.45	4.81	2.68	4.51	2.63	2.70	37.83
1911	1.37	1.82	3.39	0.76	1.99	3.22	2.54	3.43	4.59	2.82	3.60	3.13	32.66
1912	1.91	2.11	2.61	3.76	7.37	4.15	2.99	4.89	6.71	3.11	5.23	2.00	46.84
1913	3.88	1.57	5.77	1.79	4.05	4.85	5.59	2.15	4.11	3.88	1.30	2.05	40.99
Av.	2.69	2.83	3.20	2.44	3.75	4.30	4.75	3.74	3.44	3.17	3.25	2.91	40.47

RAINFALL AT HARTLAND, VT. Elevation, 665 feet.

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1890	1.95	3.24	3.67	2.10	6.50	2.75	2.81	6.37	4.44	5.61	2.09	3.50	45.03
1891	6.27	4.18	3.72	2.72	2.24	4.22	4.27	3.31	2.34	2.47	2.65	5.34	43.73
1892	4.78	2.00	1.38	0.69	7.26	4.74	2.10	7.43	2.18	1.72	3.29	1.26	38.83
1893	2.48	5.64	1.94	2.25	4.35	4.09	3.64	5.65	1.48	3.30	2.21	3.70	40.73
1894	2.57	2.04	1.31	2.17	3.83	4.41	2.83	2.58	4.58	4.25	2.58	2.88	36.03
1895	2.26	1.26	1.87	6.00	1.62	2.08	4.05	3.28	3.35	2.46	5.84	4.42	38.49
1896	0.81	4.72	7.09	2.04	1.41	4.60	2.90	3.63	4.92	3.61	3.52	0.87	40.12
1897	3.39	2.09	3.30	3.25	6.01	6.51	7.20	2.32	1.87	1.38	6.78	4.41	48.51
1898	5.94	4.22	0.82	3.42	3.99	4.18	1.89	5.02	4.62	4.48	4.67	1.75	45.00
1899	2.71	2.49	6.42	1.51	1.13	2.16	5.42	1.66	4.11	1.56	1.67	2.18	33.02
1900	4.48	5.95	5.29	0.93	2.75	2.88	2.41	3.61	1.85	3.08	5.45	2.06	40.74
1901	2.22	0.45	4.53	3.84	6.53	0.89	3.39	3.58	2.63	2.23	1.55	6.43	38.27
1902	1.90	1.65	5.27	3.75	5.22	4.13	5.89	4.28	5.61	4.19	1.10	5.48	48.47
1903	3.63	3.77	4.78	0.99	0.29	6.26	4.15	3.22	1.26	2.56	**1.38**	**3.22**	35.51
Av.	3.24	3.12	3.67	2.55	3.80	3.85	3.78	4.00	3.23	3.06	3.20	3.39	40.89

RAINFALL AT JACKSONVILLE, VT. Elevation, 1 000 feet.

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1885	...	...	...	...	...	2.70	3.41	7.96	1.87	6.06	6.16	3.75	...
1886	6.46	3.62	4.00	3.52	4.33	3.26	3.94	3.70	4.60	4.00	7.15	5.22	53.80
1887	6.43	7.05	4.49	3.51	1.40	5.58	7.11	6.68	1.66	2.56	3.57	5.72	55.76
1888	5.11	5.13	7.22	4.97	6.15	4.57	2.63	6.50	7.80	6.86	6.92	3.90	67.76
1889	5.96	2.37	2.02	3.72	4.82	5.15	9.70	4.04	3.05	4.31	7.55	4.84	57.53
1890	4.31	6.13	5.48	1.79	5.87	2.34	3.28	6.56	6.46	9.30	2.50	5.05	59.07
1891	6.85	5.25	4.23	3.73	2.67	3.84	7.45	4.74	1.47	2.79	4.10	6.56	53.68
1892	5.90	2.55	3.63	0.87	8.73	**3.03**	**3.61**	**6.86**	**2.52**	**0.72**	**4.24**	1.18	43.84
1893	2.96	7.41	3.03	4.62	7.58	3.94	2.17	9.11	2.93	5.07	2.01	4.45	55.28
1894	2.87	2.72	2.19	2.66	3.52	0.96	1.69	0.76	5.48	5.08	2.83	4.49	35.25
1895	4.10	1.41	2.12	6.31	1.24	2.99	3.56	2.49	3.33	5.21	4.65	4.72	42.13
1896	2.95	5.75	5.68	1.96	1.76	1.85	5.07	2.76	5.10	3.57	3.67	1.40	41.52
1897	3.78	4.50	5.80	3.33	3.97	5.80	10.31	2.90	2.42	1.56	9.24	7.23	60.84
1898	8.06	3.87	1.71	4.16	6.44	3.02	1.75	5.06	3.14	8.57	5.72	5.24	56.74
1899	2.22	3.10	9.00	2.43	0.84	4.25	6.12	2.06	3.92	0.70	1.76	1.68	38.08
1900	5.33	12.74	3.59	3.14	1.49	2.27	2.72	4.58	1.76	1.80	3.79	2.42	45.63
1901	2.10	0.70	5.65	10.21	5.84	1.12	3.81	3.82	4.55	2.49	1.49	3.95	45.73
1902	2.70	4.16	5.20	5.71	2.29	3.34	4.66	2.65	7.92	4.41	0.95	2.82	46.81
1903	2.14	4.23	5.78	3.01	0.70	11.65	3.84	4.75	1.44	2.40	1.91	3.68	45.53
1904	4.79	4.08	2.84	5.29	2.52	3.23	0.78	5.09	6.05	3.33	2.35	3.11	43.46
1905	6.90	3.31	1.35	1.67	1.32	3.30	3.29	4.70	7.51	3.63	1.07	3.93	41.98
1906	3.36	2.77	4.49	3.44	5.39	3.09	2.24	1.76	1.88	2.84	1.70	2.55	35.51
1907	2.89	1.19	1.28	2.32	3.46	3.47	3.29	0.49	8.26	5.40	6.42	3.81	42.28
1908	3.86	4.09	1.20	2.57	3.43	1.84	4.61	3.33	0.83	2.20	0.96	2.46	31.38
1909	4.40	4.47	1.67	2.63	4.47	2.85	1.68	3.90	5.45	4.95	2.39	0.88	39.74
1910	3.07	2.65	0.57	0.62	0.67	0.66	2.65	2.00	4.92	0.89	3.44	0.38	22.52
1911	4.04	5.06	4.57	2.24	2.06	4.94	1.21	2.00	5.20	10.93	1.81	0.81	44.87
1912	1.96	1.63	4.31	2.10	4.43	1.26	2.45	1.70	2.84	5.75	1.77	3.45	33.65
1913	2.86	1.28	4.53	1.71	2.20	0.70	0.58	0.52	2.31	1.73	3.12	1.35	22.89
Av.	4.23	4.04	3.84	3.37	3.56	3.37	3.79	3.77	4.10	4.04	3.54	3.47	45.12

RAINFALL AT LUNENBURG, VT. Elevation, 1 210 feet.

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1848	2.68	4.75	3.60	1.12	2.72	1.84	4.20	3.82	1.10	5.84	3.38	5.95	41.00
1849	2.25	3.85	6.10	2.22	2.47	2.00	4.00	1.75	2.20	2.25	3.71	3.00	35.80
1850	2.90	3.95	4.50	2.00	3.50	1.75	3.90	4.00	2.05	4.90	3.50	3.05	40.00
1851	4.00	1.15	3.50	7.10	0.85	3.60	4.18	1.25	2.80	3.00	1.50	0.57	33.50
1852	2.75	3.75	4.10	5.25	5.80	4.20	2.75	2.00	3.25	3.75	0.45	0.95	39.00
1853	4.00	4.55	2.10	2.80	3.10	2.80	4.20	4.50	3.15	2.80	4.00	3.75	41.75
1854	4.80	3.90	3.25	2.10	2.20	2.50	1.10	0.75	3.75	4.20	4.05	4.00	36.60
1855	1.40	2.25	4.25	3.75	4.70	5.80	3.20	2.50	3.25	2.20	2.00	2.95	38.25
1856	3.25	3.00	5.20	2.10	2.40	3.75	3.75	3.20	3.00	3.15	3.00	4.00	39.80
1857	2.60	2.90	4.50	3.00	2.80	3.25	3.50	3.00	2.95	4.18	2.50	2.07	37.25
1858	3.25	3.00	1.50	4.10	2.50	2.85	2.75	3.50	3.25	3.80	5.00	3.00	38.50
1859	1.07	2.05	4.25	1.25	2.75	4.00	2.25	3.06	4.50	2.50	2.85	4.77	35.30
1860	2.25	2.16	1.98	1.56	1.50	1.06	3.62	9.06	4.52	2.32	5.37	3.50	38.90
1861	3.20	3.00	2.95	5.85	6.75	4.00	6.00	1.75	5.00	4.62	2.18	1.70	47.00
1862	3.80	5.02	3.56	2.40	1.75	1.70	2.75	6.00	4.00	4.00	6.75	4.07	45.80

RAINFALL AT LUNENBURG, VT. — *Continued.*

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1863	5.45	1.40	4.70	2.85	4.50	1.50	8.70	2.90	3.05	3.60	2.25	5.10	46.00
1864	2.63	1.88	2.92	1.90	6.85	1.32	2.00	3.30	2.75	6.12	3.70	3.65	39.02
1865	3.35	1.70	5.13	3.35	6.55	2.75	3.92	1.00	4.62	3.35	2.95	1.02	39.69
1866	1.55	3.35	1.40	2.50	2.00	3.00	6.00	5.25	6.00	1.95	3.25	1.85	38.10
1867	2.05	4.30	2.60	2.70	9.47	3.75	3.33	3.75	2.00	1.50	2.45	1.75	39.65
1868	1.87	1.45	2.80	1.30	5.75	4.40	5.05	1.83	8.02	1.30	7.15	2.45	43 37
1869	4.30	4.12	4.45	2.05	2.85	5.00	2.75	2.50	2.60	8.10	2.21	3.02	43.95
1870	4.55	4.00	1.47	2.50	3.60	3.50	4.34	6.42	3.00	3.95	6.52	1.30	45.15
1871	3.15	2.10	3.65	5.72	3.62	2.12	4.35	7.35	2.30	3.90	1.00	3.70	42.96
1872	2.00	3.05	2.70	2.00	8 20	7.33	7.25	12.58	3 48	2.27	5.05	5.00	60.91
1873	3.85	3.35	4.50	2.65	2.64	2.00	3.95	2.50	4.75	5.45	2.22	2.65	40.51
1874	3.70	1.80	2.25	4.05	2.95	7.06	4.98	4.38	1.35	1.15	2.71	3.07	39.45
1875	3.60	4.03	3.00	2.85	3.73	5.70	2.55	3.45	4.35	5.26	2.92	1.40	42.84
1876	3.55	3.60	3.00	2.75	4.70	7.05	5.22	1.35	5.94	1.50	1.67	2.82	43.15
1877	2.15	0.65	6.40	2.35	1.05	3.00	4.22	5.95	2.05	4.70	3.65	1.87	38.04
1878	1.65	0.80	2.25	6.15	2.45	4.65	3.35	4.45	1.20	2.60	2.70	2.30	34.55
1879	3.45	2.75	3.15	2.70	1.45	5 80	5.00	4.67	3.78	2.20	4.18	4.30	43.43
1880	2.25	2.60	1.47	1.40	3.05	2.30	2.45	3.79	2.40	4.70	2.18	2.55	31.14
1881	2.90	1.70	2.60	1.00	4.55	2.20	3.09	2.75	2.45	4.85	5.19	4.92	38.20
1882	3.75	3.75	1.75	1.55	2.20	4.93	2.85	1.05	5.26	1.45	1.27	2.40	32.21
1883	2.10	3.65	2.40	1.30	4.00	4.34	4.80	1.18	2.90	4.50	2.83	2.60	36.60
1884	3.30	2.30	4.60	1.26	4.45	1.95	2.50	2.55	2.55	5.00	2.50	2.80	35.76
1885	3.40	2.35	2.25	0.60	1.00	3.88	6.46	5.67	3.00	4.51	2.55	1.70	37.37
1886	2.65	1.67	0.90	0.75	2.37	1.70	2.32	4.70	3.98	1.40	3.45	3.40	29.29
1887	3.00	3.80	2.20	1.75	2.23	3.84	4.88	2.36	1.02	2.39	2.15	3.25	32.87
1888	3.05	1.30	4.80	0.90	4.55	2.69	1.20	6.57	5.41	5.25	4.84	3.07	43.63
1889	3.53	1.84	4.30	1.00	3.02	5.43	5.37	1.74	5.17	3.58	3.61	1.48	40.07
1890	3.20	2.68	4.14	2.01	7.29	4.57	3.56	6.15	3.92	2.72	2.46	3.10	45.80
1891	3.75	1.95	2.16	2.18	3.47	1.92	5.03	2.67	2.14	0.51	2.50	2.33	30.61
Av.	3.11	2.87	3.38	2.62	3.73	3.60	4.04	3.84	3.49	3.56	3.31	2.98	40.53

RAINFALL AT MANCHESTER, VT. Elevation, 980 feet.

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1900	3.61	4.58	2.87	1.46	4.03	2.02	4.18	5.43	2.19	2.64	3.53	2.10	38.64
1901	1.35	0.56	3.86	5.30	5.09	2.11	6.06	4.95	4.02	1.79	2.84	4.05	41.98
1902	1.37	1.51	1.74	4.45	3.58	3.70	7.65	3.92	4.06	5.78	1.44	5.30	44.50
1903	2.59	3.10	3.54	1.50	0.86	5.59	2.70	6.19	1.57	4.55	2.14	1.92	36.25
1904	2.00	1.11	1.48	2.72	4.08	4.15	5.97	4.70	7.42	3.19	0.69	2.13	39.64
1905	3.14	1.05	1.93	2.22	2.27	5.24	4.73	3.61	6.08	1.61	4.04	3.65	39.57
1906	1.73	2.17	2.82	3.48	6.95	4.08	3.88	1.95	3.77	4.29	1.95	2.08	39.15
1907	1.65	0.75	0.62	3.02	3.17	4.26	4.00	2.18	8.03	4.95	3.76	1.80	38.19
1908	1.55	3.12	2.90	3.99	4.86	2.88	3.18	4.60	0.63	2.02	1.16	1.42	32.31
1909	4.23	5.35	2.19	2.53	5.05	3.66	2.08	3.32	4.60	2.35	1.41	1.61	38.38
1910	1.72	2.99	1.43	2.16	4.51	2.81	2.48	3.37	4.35	1.89	2.63	0.87	31.21
1911	1.93	0.67	1.50	0.61	0.29	1.70	0.31	2.77	1.92	3.00	1.83	1.15	17.68
1912	1.36	**1.66**	3.22	0.71	**6.54**	0.49	1.72	3.79	**5.98**	**3.57**	2.69	3.59	35.32
1913	3.10	1.41	5.08	1.29	3.15	0.47	1.14	0.07	0.13	**6.20**	2.87	2.26	27.17
Av.	2.24	2.14	2.51	2.53	3.89	3.08	3.58	3.63	3.91	3.42	2.36	2.42	35.71

RAINFALL AT NEWFANE, VT. Elevation, 600 feet.

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1826	...	...	...	...	0.90	5.90	3.60	9.20	5.30	2.40	4.70	4.80	....
1827	7.00	4.00	3.60	7.80	4.60	4.80	5.20	4.40	8.60	6.50	4:80	5.10	66.40
1828	3.90	4.90	2.80	2.80	7.80	4.30	11.70	4.80	10.70	2.50	9.70	0.40	66.30
1829	8.40	5.40	3.00	4.30	3.20	3.20	3.40	0.90	1.70	2.30	4.50	3.30	43.60
1830	2.10	1.70	6.90	2.90	2.80	6.70	5.30	3.30	2.40	3.70	8.00	6.10	51.90
1831	3.20	4.10	5.20	7.70	5.80	4.70	5.40	4.30	8.70	7.10	4.00	2.00	62.20
1832	5.70	3.00	3.80	4.20	4.30	1.80	3.20	5.90	2.80	4.60	4.00	3.50	46.80
1833	4.30	2.60	2.70	2.10	8.20	5.90	2.70	5.70	2.80	...	...	...	....
Av.	5.05	3.85	4.22	4.95	4.75	4.25	5.70	3.93	5.82	4.45	5.83	3.40	56.20

RAINFALL AT NORTHFIELD, VT. Elevation, 876 feet.

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1887	...	...	4.68	3.37	1.39	4.12	5.33	4.53	1.78	1.47	3.82	5.88	...
1888	4.99	2.73	4.81	2.87	3.51	6.17	1.30	3.43	6.27	3.53	3.82	2.46	45.89
1889	3.90	2.18	2.05	1.10	2.48	5.02	4.65	1.59	4.06	3.57	3.45	2.61	36.66
1890	2.76	3.29	2.54	1.94	4.32	2.84	2.87	6.98	2.95	3.49	2.28	1.91	38.17
1891	3.79	2.13	2.68	2.41	2.46	2.04	3.20	4.78	0.98	1.87	2.14	2.63	31.11
1892	3.21	1.73	1.13	0.44	3.30	5.66	2.88	6.50	1.74	1.52	3.43	1.13	32.67
1893	1.78	2.47	1.21	1.63	3.97	2.07	3.74	6.14	1.91	1.54	1.98	2.92	31.36
1894	2.56	1.54	1.06	1.32	3.33	1.71	1.64	3.23	2.99	3.50	2.58	3.46	28.92
1895	1.99	0.82	1.36	4.60	3.38	2.11	2.82	4.64	2.60	0.45	5.68	4.75	35.20
1896	0.87	4.45	6.41	0.51	1.44	1.62	5.99	2.27	3.48	2.42	3.55	0.81	33.82
1897	3.46	1.53	2.73	2.73	3.46	3.77	8.04	2.71	1.43	1.16	4.86	3.26	39.14
1898	3.30	3.72	0.64	2.74	2.10	2.28	1.66	5.22	2.66	2.87	1.97	1.36	30.52
1899	1.77	1.69	4.03	1.20	1.52	1.60	3.41	0.77	4.19	2.49	2.38	2.31	27.36
1900	2.61	4.32	4.49	1 10	1.60	2.33	3.02	4.11	2.59	2.61	3.99	1.34	34.11
1901	1.43	0.18	3.31	3.12	3.91	2.97	4.86	3.02	1.79	1.52	0.89	4.42	31.42
1902	2.09	2.37	4.97	3.84	3.42	3.84	2.91	4 06	3.31	3.01	1.06	3.45	38.33
1903	2.21	3.53	3.87	0.97	0.19	4.75	2.71	2.94	1.21	2.75	1.04	2.92	29.09
1904	2.38	0.56	1.84	2.95	2.30	1.33	3.53	3.54	5.06	2.29	0.56	1.32	27.66
1905	1.53	0.73	2.06	1.93	1.74	3.89	6.17	4.02	4.35	1.52	1.73	2.64	32.31
1906	1.38	2.18	2.33	1.05	4.57	4.40	4.30	3.55	1.87	3.16	2.53	3.43	34.75
1907	1.48	0.71	1.87	4.66	1.92	3.70	3.45	1.47	6.08	5.14	3.32	3 97	37.77
1908	1.93	4.44	2.17	2.20	3.73	2.68	2.05	3.73	0.35	1.99	1.18	2.62	29.07
1909	3.55	4.85	1.85	2.43	3.54	2.94	2.53	2.53	3.05	1 47	2.02	1.58	32.34
1910	2.80	3.63	0.60	2.17	4.51	3.18	1.96	2.57	4.72	1.68	2.19	1.70	31.71
1911	1.25	1.61	2.07	1.10	0.99	2.36	3.41	4.46	2.53	3.96	2.17	2.01	27.92
1912	1.72	2.37	2.49	1.95	6.81	1.05	3.31	3.46	3.90	[illegible].45	3.56	1.90	37.00
1913	2.84	0.92	6.30	1.61	3.01	1.29	3.37	1.02	1.84	4.97	1.77	2.41	31.35
Av.	2.45	2.33	2.73	2.10	2.98	2.98	3.45	3.57	3.00	2.65	2.54	2.51	33.29

RAINFALL AT NORWICH, VT. Elevation, 550 feet.

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1893	1.34	4.50	1.56	1.49	3.46	3.45	3.51	4.20	1.66	3.25	1.55	2.99	32.96
1894	2.49	1.97	1.18	1.69	4.08	4.37	2.00	2.55	4.18	3.48	2.37	2.71	33.07
1895	1.53	0.76	1.52	4.50	1.98	2.95	4.22	3.92	2.79	1.46	5.38	3.95	34.96
1896	0.64	3.74	5.75	0.89	1.31	2.28	4.34	3.82	4.43	4.03	3.01	0.77	35.01
1897	2.90	2.58	3.11	2.92	5.82	6.81	6.58	2.43	1.63	1.00	6.13	4.00	45.91
1898	4 40	4.41	1.07	3.03	3.25	3.85	1.11	4.01	3.98	3.32	3.87	1.54	37.84
1899	2 45	2.59	6.39	1.27	1.56	3.53	4.43	2.08	5.33	1.54	1.48	2.45	35 10

RAINFALL AT NORWICH, VT.—*Continued.*

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1900	4.80	5.66	4.58	0.92	2.72	2.65	3.87	2.93	1.48	3.04	4.98	2.26	39.89
1901	2.29	0.25	4.01	3.48	6.25	1.24	4.81	3.30	3.28	1.95	1.63	5.32	37.81
1902	1.74	1.00	5.20	3.80	3.32	3.47	4.03	3.49	4.24	4.99	0.97	4.78	41.03
1903	4.13	3.78	4.43	1.13	0.76	7.02	2.85	3.61	1.55	2.57	1.02	3.69	36.54
1904	3.60	1.61	2.35	5.04	3.10	1.34	2.96	3.69	6.01	3.01	0.75	2.05	35.51
1905	2.24	1.70	2.46	1.62	1.96	4.57	7.02	4.31	6.96	1.54	2.08	2.74	39.20
1906	2.20	2.73	3.46	2.07	6.60	3.69	4.21	2.93	1.95	3.66	2.02	3.37	38.89
1907	2.60	1.40	2.33	3.38	3.43	3.57	1.89	0.91	6.92	5.00	2.97	2.98	37.38
1908	2.55	4.15	1.61	1.66	4.53	2.30	3.61	5.09	0.65	2.11	1.39	2.86	32.51
1909	4.57	4.88	2.17	2.74	3.22	2.79	1.70	3.97	3.76	1.25	2.30	2.25	35.60
1910	3.67	4.47	0.78	2.85	3.39	3.81	1.72	4.50	3.91	1.41	2.51	2.62	35.64
1911	1.91	3.51	2.65	0.81	1.39	3.13	6.29	2.54	4.78	4.57	2.60	2.53	36.71
1912	3.23	1.74	4.79	3.08	5.90	1.14	3.05	3.78	4.31	5.17	2.81	2.66	41.66
1913	3.23	1.80	5.62	1.51	4.82	1.02	2.93	2.05	2.51	5.00	1.80	3.14	35.43
Av.	2.79	2.82	3.19	2.38	3.47	3.28	3.67	3.34	3.63	3.02	2.55	2.94	37.08

RAINFALL AT RUTLAND, VT. Elevation, 550 feet.

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1789	3.50	2.78	3.10	3.01	4.72	3.92	2.31	2.11	2.48	5.66	4.10	3.49	41.18

RAINFALL AT SOMERSET, VT. Elevation, 2 096 feet.

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1911	...	...	...	...	...	...	...	...	...	...	3.51	4.04	....
1912	3.39	3.34	4.60	4.03	7.04	2.96	3.82	4.18	4.94	8.04	3.62	6.36	56.32
1913	6.54	4.05	8.29	3.74	4.83	0.91	3.76	2.58	3.49	5.15	6.36	3.27	52.97
Av.	4.96	3.70	6.45	3.88	5.93	1.94	3.79	3.38	4.21	6.60	4.99	4.81	54.64

RAINFALL AT ST. JOHNSBURY, VT. Elevation, 711 feet.

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1894	**2.56**	**1.28**	2.30	1.86	3.53	2.55	1.62	2.92	2.34	1.77	1.97	2.45	27.15
1895	1.89	0.71	1.65	3.55	3.15	2.98	3.19	4.20	3.16	0.51	6.08	3.82	34.89
1896	0.67	3.21	4.33	1.14	1.80	2.42	3.79	3.26	3.24	2.41	3.45	0.95	30.67
1897	2.15	1.80	2.68	2.84	4.33	6.02	6.40	3.99	2.17	1.17	5.19	3.90	42.64
1898	3.68	2.64	0.97	2.45	2.46	3.55	6.60	5.81	5.42	3.18	2.63	1.46	40.85
1899	2.22	2.76	5.33	1.39	1.22	2.09	4.36	3.24	3.58	2.40	2.28	2.20	33.07
1900	4.07	4.73	3.86	1.49	2.66	1.62	4.21	3.42	2.84	2.70	6.15	0.95	38.70
1901	2.06	0.56	3.31	1.74	3.40	4.07	4.96	4.44	2.64	2.31	1.60	4.06	35.15
1902	0.89	1.08	4.16	2.55	5.14	4.45	4.48	6.44	3.75	3.98	1.44	2.49	40.85
1903	3.24	2.25	5.13	1.23	0.04	3.54	5.91	2.90	1.08	2.65	1.00	2.27	31.24
1904	1.81	1.01	1.26	2.67	3.64	2.40	2.81	4.39	5.15	1.81	1.09	1.63	29.67
1905	1.30	1.08	2.10	2.22	2.68	3.36	4.35	4.62	4.79	1.60	2.10	2.92	33.12
1906	2.10	2.51	1.82	0.54	3.71	4.35	3.68	4.71	2.70	3.13	1.74	2.75	33.74
1907	1.58	1.24	2.62	4.60	2.58	3.38	4.46	2.35	8.11	5.06	2.47	3.90	42.35
1908	2.09	3.94	1.97	2.27	3.75	4.78	3.11	5.21	0.68	1.66	1.10	2.67	33.23
1909	2.86	1.93	0.72	3.51	4.28	3.33	2.83	2.47	1.06	3.73	1.97	1.09	29.78
1910	2.12	4.55	1.46	3.25	4.25	2.90	2.92	4.53	4.55	1.44	2.37	2.12	36.46
1911	1.74	2.29	3.50	1.01	1.08	2.54	4.73	5.19	4.32	3.58	2.50	3.05	35.53
1912	2.13	2.04	2.76	3.14	6.56	2.04	3.17	4.80	5.56	2.15	2.78	2.97	40.10
1913	3.25	1.32	6.76	1.63	3.36	1.40	7.56	1.44	1.45	5.94	1.25	2.78	38.14
Av.	2.22	2.15	2.93	2.25	3.18	3.19	4.26	4.02	3.56	2.53	2.56	2.52	35.37

RAINFALL AT STRAFFORD, VT. Elevation, 500 feet.

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1873	...	...	6.60	0.60	1.50	3.85	6.77	3.50	4.30	6.80	2.41	5.35	...
1874	4.15	1.90	3.50	12.20	3.50	1.80	5.60	2.00	3.00	0.50	0.50	2.00	40.65
1875	4.20	1.02	2.95	2.20	3.80	4.80	4.30	4.50	3.50	4.30	2.60	0.15	38.32
1876	2.50	5.00	7.10	3.20	4.20	6.30	5.40	1.50	4.75	3.00	1.70	3.80	48.45
1877	3.20	0.30	5.90	2.50	0.40	4.90	4.50	3.30	2.70	5.30	5.60	1.50	40.10
1878	1.70	2.40	1.55	5.20	3.20	4.20	4.00	4.00	2.40	3.60	3.80	5.90	41.95
1879	3.70	2.40	3.60	2.55	3.80	2.60	3.00	3.50	4.60	1.90	5.50	3.90	41.05
1880	2.70	2.40	2.11	1.80	0.80	3.60	6.10	6.30	2.50	3.10	2.91	1.20	35.52
1881	2.70	2.60	2.50	0.60	3.50	3.20	2.00	3.60	2.30	3.80	4.70	5.60	37.10
1882	2.52	2.90	1.81	1.21	4.30	1.90	4.00	1.40	4.10	1.20	0.90	2.70	28.94
1883	2.40	3.20	2.60	2.00	3.10	3.00	6.00	2.40	3 60	2.60	1.70	2.50	35.10
1884	3.00	4.70	5.20	2.10	4.55	1.60	3.15	3.40	0.70	1.70	4.40	3.80	38.30
1885	4.40	2.00	1.80	1.80	2.00	1.60	4.90	7.90	2.70	5.90	4.30	3.60	42.90
1886	4.60	2.70	2.20	2.60	2.90	2.20	3.90	3.20	4.52	2.03	4.90	2.70	38.45
1887	5.50	5.90	4.30	2.50	2.20	4.70	5.60	5.00	1.70	2.00	3.70	4.20	47.30
1888	3.80	2.00	4.60	3.00	3.60	2.50	3.00	4.70	6.10	4.85	6.20	3.50	47.85
1889	4.80	3.25	4.30	1.40	3.60	5.20	6.50	2.00	5.00	2.90	5.50	3.00	47.45
1890	3.70	4.40	3.70	2.10	7.60	2.90	4.00	8.85	3.95	4.80	2.00	3.30	51.30
1891	6.10	3.30	3.20	2.40	3.10	3.62	3.85	3.50	1.60	2.00	2.05	3.50	38.22
1892	4.20	1.50	1.50	1.05	7.00	7.86	0.91	4.50	1.55	1.90	3.35	1.55	36.87
1893	1.90	5.10	1.90	2.12	2.58	2.05	3.34	5.78	1.58	2.65	1.75	5.30	36.05
1894	3.45	3.80	1.10	1.40	4.01	6.15	1.22	2.95	3.70	3.10	3.42	3.00	37.30
1895	1.90	1.51	1.39	3.11	2.60	2.17	2.08	2.82	2.40	1.78	4.86	5.11	31.73
1896	1.05	4.35	4.85	0.61	0.90	1.88	4.56	3.06	3.37	3.30	3.35	0.61	31.89
1897	3.15	1.95	3.15	3 05	5.52	5.25	6.85	6.32	1.25	1.00	5.35	3.54	46.38
Av.	3.39	2.94	3.20	2.61	3.45	3.58	4.12	4.02	3.07	2.88	3.54	3.17	39.97

RAINFALL AT VERNON, VT. Elevation, 310 feet.

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1886	4.62	3.07	2.91	2.66	2.88	2.38	4.49	2.32	4.67	3.02	4.40	3.34	40.76
1887	5.38	5.79	3.54	3.58	1.24	6.18	6.12	10.27	1.22	1.57	2.84	3.62	51.35
1888	4.67	4.33	7.27	3.77	3.98	2.37	1.16	6.88	10.94	6.71	5.43	3.01	60.52
1889	4.97	1.90	1.73	1.89	3.91	3.84	11.02	2.16	5.58	4.64	6.40	4.55	52.59
1890	3.31	4.93	5.17	1.91	5.19	1.83	3.01	6.46	6.75	6.66	1.96	2.18	49.36
1891	7.52	2.76	2.59	3.37	1.75	3.47	4.84	3.30	0.83	2.02	2.80	3.89	39.14
1892	5.19	2.23	1.93	0.58	5.69	2.90	3.88	7.26	3.04	0.99	4.73	1.07	39.49
1893	3.77	5.51	2.94	4.29	5.19	3.80	1.64	7.86	2.73	3.54	1.62	4.16	47.05
1894	2.08	2.31	1.28	1.70	2.69	2.24	2.34	0.57	6.13	4.15	2.83	3.04	31.36
1895	3.18	0.76	2.00	5.81	1.25	2.44	2.97	3.61	3.80	3.99	5.13	2.91	37.85
1896	0.94	4.00	6.03	1.19	2.06	1.13	3.76	2.32	5.65	2.51	3.86	0.91	34.36
1897	3.71	2.18	3.68	2.68	3.49	5.96	13.65	2.98	2.13	1.75	7.41	7.36	56.98
1898	6.66	4.68	1.19	3.70	4.52	6.95	2.33	4.91	2.19	8.18	2.94	2.20	50.45
1899	3.15	3.68	7.22	1.67	0.89	5.35	5.77	1.96	4.03	2.08	1.79	3 07	40.66
1900	4.11	7.22	5.49	1.92	3.81	3.34	4.10	3.70	1.92	2.68	10.12	1.97	50.38
1901	1.93	0.54	6.54	6.17	4.66	1.76	5.24	5 74	4.82	3.87	1.22	7.61	50.10
1902	1.64	...	...	4 77	1.80	3.46	8.01	3.06	...	...	...	...	...
Av.	4.07	3.49	3.84	2.93	3.33	3.50	4.77	4.52	4.15	3.65	4.09	3.43	45.77

RAINFALL AT WELLS, VT. Elevation, 750 feet.

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1892	4.92	1.84	1.91	0.73	6.15	7.41	4.64	6.45	2.07	1.76	3.84	1.07	42.82
1893	1.56	5.83	1.96	1.82	4.12	1.63	4.77	9.18	2.11	2.54	1.38	3.66	40.56
1894	1.96	1.61	1.54	1.35	2.70	3.25	2.37	2.41	3.31	3.67	2.62	1.91	28.70
1895	1.38	0.95	1.78	3.36	2.63	2.81	5.06	5.07	2.71	1.03	5.25	3.20	35.23
1896	0.83	3.23	6.24	1.23	1.85	2.88	3.06	4.99	6.61	3.62	3.36	1.20	39.10
1897	3.41	1.55	3.88	3.19	5.60	5.26	10.07	5.74	2.38	1.28	6.59	3.33	52.28
1898	4.80	5.25	1.04	2.58	2.82	3.57	2.46	7.70	5.16	4.58	3.56	1.79	45.31
1899	1.85	1.87	5.63	1.68	1.84	2.23	3.99	0.71	5.61	1.78	1.68	2.98	31.85
1900	3.49	4.75	3.70	0.96	2.51	3.44	3.34	3.92	2.58	2.68	5.34	1.94	38.65
1901	1.32	0.94	4.82	2.89	3.14	2.41	3.66	3.90	2.49	1.93	2.02	4.28	33.80
1902	1.39	1.55	3.60	2.40	3.49	4.09	7.54	3.00	3.46	5.31	1.03	3.80	40.66
1903	2.70	3.13	6.45	0.91	0.43	4.68	2.69	5.93	2.08	3.82	1.85	2.65	37.32
1904	2.38	2.11	1.79	3.47	3.76	2.88	4.92	3.48	6.10	3.38	1.15	1.93	37.35
1905	1.74	1.57	2.62	2.51	2.29	6.77	5.09	2.78	5.90	1.60	2.11	2.44	37.42
1906	2.32	2.74	3.21	2.12	6.39	4.58	3.37	2.67	2.18	3.80	2.12	3.13	38.63
1907	2.04	1.08	2.02	3.75	4.00	2.33	2.83	1.20	8.20	4.78	3.39	3 66	39.28
1908	1.97	3.42	1.89	2.96	3.88	2.87	3.02	3.59	0.81	2.74	1.00	2.28	30.43
1909	4.22	5.33	2.29	3.30	4.91	2.86	1.76	3.68	4.08	1.19	1.84	1.92	37.38
1910	4.19	5.01	1.06	2.14	4.11	2.75	2.04	5.03	5.99	1.53	3.06	3.33	40.24
1911	2.71	1.69	1.73	0.88	1.68	2.86	4.41	3.27	4.51	4.90	2.44	3.33	34.41
1912	2.20	1.66	4.34	3.72	6 54	1.22	3.40	4.49	5.98	3.57	2.50	3.18	42.80
1913	3.75	2.31	8.22	1.75	3.68	1.32	2.84	1.89	2.62	6.20	1.66	2.87	39.11
Av.	2.59	2.70	3.26	2.26	3.57	3.37	3.97	4.14	3.95	3.08	2.72	2.72	38.33

RAINFALL AT WOODSTOCK, VT. Elevation, 700 feet.

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1857	2.83	1.50	2.53	3.67	6.46	3.45	4.49	6.12	1.53	6.32	2.55	4.00	45.45
1858	2.16	1.40	0.82	1.90	3.44	2 66	5.40	2.54	5.34	4.17	3.38	2.49	35.70
1868	3.50	...	...	...	...	...	...	...	...	...	...	2.50	...
1869	2.20	4.00	...	...	...	2.85	1.76	2.24	3.44	12.90	2.29	2.94	...
1870	6.20	5.21	2.60	4.27	1.88	5.35	1.82	1.03	4.93	3.80	1.87	2.58	41.54
1871	1.96	3.09	3.37	2.37	3.74	1.54	4.67	3.93	1.73	2.06	2.83	2.51	33.80
1872	1.55	2.65	2.76	1.26	3.78	4.51	5.48	6.75	2.85	4.58	3.39	2.76	42.32
1873	4.49	2.02	4.95	1.89	1.72	1.26	7.61	1.73	3.84	7.66	3.71	3.18	44.06
1874	3.12	2.32	1.28	5.24	3.78	3.83	4.29	1.99	3.51	1.43	2.02	1.28	34.09
1875	3.16	2.10	3.34	2.43	4.19	5.03	3.41	3.34	2.11	4.27	2.90	1.76	38.04
1876	2.81	4.46	6.71	2.30	2.13	3.20	3.69	0.81	4 63	0.76	2.89	3.91	38.30
1877	2:67	0.30	4.52	2.22	1.32	6.50	6.57	3.58	1.07	5.96	4.95	0.69	40.35
1878	3.34	1.97	1.41	4.94	2.44	4.58	2.67	3.53	1.70	2.67	4.13	6.24	39.62
1879	2.33	2.55	4.15	2.99	0.62	5.60	3.50	2.84	4.03	0.87	4.66	3.18	37.32
1880	3.10	2.71	1.67	1.98	2.70	1.74	3.85	1.47	2.64	3.16	2.67	2.01	29.70
1881	2.96	2.25	2.76	0.95	3.62	2.19	3.74	1.62	2.76	3.19	3.09	4.51	33.64
1882	2.18	3.86	1.72	1.28	4.43	2.33	3.18	1.75	6.47	0.89	0.61	3.20	31.90
1883	2.41	3.20	2.08	1.48	3.14	3.03	5.56	1.04	2.83	3.39	2.15	2.38	32.69
1884	3.22	3.62	4.48	2.31	3.00	1.88	2.36	2.12	0.70*	2.04	4.35	4.09	34.17
1885	4.42	2.85	1.55	1.98	2.04	2.28	3.29	8.48	2.35	4.70	1.53	2.80	41.27
1886	4 60*	2.70*	2.20*	2.60*	2.90*	2.20*	3.90*	3.20*	4.52*	2.03*	4.90*	2.70*	38.45
1887	5.50*	5.90*	4.30*	2.50*	2.20*	4.70*	5.95	4 50	1.70*	1.38	3.52	3.87	46.02
1888	2.70	2.92	4.53	3.00*	3.60*	2.50*	3.00*	4.70*	6.10*	4.85*	6.20*	3.50*	47.60

RAINFALL AT WOODSTOCK, VT. — *Continued.*

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1889	4.80*	3.25*	4.30*	1.40*	3.60*	5.20*	6.50*	2.00*	5.00*	2.90*	5.50*	3.00*	47.45
1890	3.70*	4.40*	3.70*	2.10*	7.60*	2.90*	4.00*	8.85*	3.95*	4.80*	2.00*	3.30*	51.30
1891	6.10*	3.30*	3.20*	2.40*	3.10*	3.62*	3.85*	3.50*	1.60*	2.00*	2.05*	3.50*	38.22
1892	4.20*	1.50*	1.50*	1.05*	7.00*	4.08	1.25	5.41	1.44	0.91	2.57	1.39	32.30
1893	1.66	5.15	1.73	2.19	5.62	2.22	3.05	5.39	1.36	3.02	1.57	3.67	36.63
1894	2.71	2.20	1.50	1.83	3.71	2.93	2.25	2.95	4.07	4.27	2.58	2.13	33.13
1895	2.21	0.73	1.77	7.15	2.46	2.09	3.25	2.70	2.91	1.46	5.36	4.84	36.93
1896	1.43	4.63	4.68	1.53	1.54	2.34	3.87	3.52	4.44	3.54	3.20	0.72	35.44
1897	3.76	2.09	3.21	3.63	5.54	6.23	6.04	1.61	1.99	1.06	5.57	3.54	44.27
1898	6.30	3.49	0.91	3.51	2.92	2.37	2.93	3.82	3.94	3.74	3.94	1.65	39.52
1899	1.85	2.70	6.96	1.22	0.92	2.02	4.71	2.70	3.44	2.10	1.49	2.21	32.32
1900	3.81	4.76	4.98	0.51	2.96	3.60	2.59	3.80	1.00	2.79	5.35	2.25	38.40
1901	2.06	0.35	4.17	5.23	6.64	1.33	3.50	2.32	2.06	1.65	1.47	5.34	36.12
1902	2.23	2.69	3.97	3.81	3.59	3.55	4.61	3.89	5.85	4.50	0.74	4.99	44.42
1903	3.11	3.59	4.33	1.03	0.80	6.05	5.14	4.03	0.73	3.69	1.38	3.22	37.10
1904	1.78	0.99	1.71	5.92	2.93	1.24	3.39	4.56	5.86	2.98	1.44	1.54	34.34
1905	2.00	1.30	2.18	1.63	1.60	4.82	6.77	3.75	6.60	1.71	3.51	2.68	38.55
1906	1.51	2.20	2.93	0.96	6.92	4.77	2.78	2.98	1.50	3.35	2.03	3.51	35.44
1907	1.77	0.79	2.00	3.57	3.36	3.87	2.81	0.81	7.07	4.16	3.79	3.76	37.76
1908	2.29	4.20	1.24	4.39	5.12	2.54	3.19	2.67	1.03	1.33	1.09	2.71	31.80
1909	4.46	5.14	2.91	2.24	4.28	3.57	2.27	3.89	3.92	1.20	2.15	2.75	38.78
1910	3.99	4.86	0.91	2.72	3.57	2.71	1.26	4.12	4.95	1.46	2.44	2.14	35.13
1911	1.80	2.50	3.52	0.97	2.39	2.44	6.72	2.69	1.19	5.07	2.31	2.68	37.28
1912	2.48	2.22	3.90	**2.51**	6.67	0.99	2.78	3.13	4.73	4.84	3.14	3.00	40.39
1913	3.69	1.63	6.59	1.62	4.30	0.57	3.08	1.80	1.23	6.27	1.92	3.41	36.11
Av.	3.12	2.83	3.10	2.58	3.53	3.23	3.93	3.35	3.31	3.15	3.04	2.99	38.16

* From Strafford, Vt.

MASSACHUSETTS.

RAINFALL AT ACUSHNET, MASS. Elevation, 50 feet.

(New Bedford Water Works.)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1878	8.03	5.75	6.71	6.13	3.29	2.66	2.89	3.60	1.30	8.88	7.96	6.77	63.97
1879	3.31	2.57	6.27	7.13	2.25	4.34	4.89	5.74	2.86	1.02	4.44	4.63	49.45
1880	2.02	3.13	5.12	5.79	1.32	1.94	9.46	7.91	2.27	3.87	3.49	3.28	49.60
1881	5.82	7.48	7.21	2.16	3.17	8.92	1.80	1.28	5.24	0.75	6.51	2.98	53.32
1882	3.80	6.40	3.99	5.05	4.55	3.48	3.02	1.36	7.78	4.39	2.58	3.70	50.10
1883	5.92	4.44	1.63	2.80	3.70	2.14	4.97	0.70	2.68	8.05	3.82	3.55	44.40
1884	5.55	6.68	5.53	6.03	3.20	4.45	4.67	8.17	0.96	2.47	4.84	8.05	60.60
1885	6.14	4.03	1.38	2.13	3.63	3.61	2.54	3.48	1.49	6.14	2.23	4.78	41.58
1886	6.20	8.86	4.87	2.44	3.99	1.38	2.87	3.50	2.15	4.58	5.06	7.47	53.37
1887	5.71	5.80	5.65	4.85	2.82	3.51	2.68	3.22	1.01	4.56	3.19	4.92	47.92
1888	5.50	3.57	5.98	2.38	6.26	1.58	5.67	4.28	10.35	3.88	11.47	5.00	65.92
1889	7.42	2.69	4.21	5.51	5.17	3.03	5.17	6.82	3.68	6.10	8.77	2.71	61.28
1890	3.07	3.16	6.11	4.12	8.00	5.01	3.07	4.52	7.83	10.66	1.52	5.47	62.54
1891	10.08	7.16	7.34	3.80	2.04	1.80	2.73	2.32	2.10	8.73	4.07	5.02	57.19
1892	5.89	2.49	5.41	2.29	6.14	2.29	2.03	6.00	3.56	2.24	7.67	1.27	47.28
1893	2.83	8.13	6.06	6.17	5.78	3.59	1.71	4.69	3.18	4.10	3.98	6.59	56.81
1894	5.46	5.10	1.91	4.51	5.02	1.83	2.04	1.50	3.12	9.44	5.08	6.19	51.23

RAINFALL AT ACUSHNET, MASS. — *Continued.*

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1895	3.58	0.69	3.67	4.22	4.64	2.56	3.23	2.92	1.40	6.04	4.07	2.88	39.90
1896	2.35	3.76	6.33	1.07	3.55	5.83	4.38	3.30	8.05	3.37	3.67	3.67	49.33
1897	3.82	2.82	3.11	3.73	6.70	3.31	4.45	8.23	0.81	1.56	7.43	3.51	49.48
1898	5.09	7.08	3.75	5.59	6.04	1.13	6.54	7.06	1.84	9.66	9.40	2.24	65.42
1899	5.93	5.61	7.81	1.64	1.65	3.53	3.27	1.78	6.99	1.62	2.40	1.89	44.12
1900	3.24	5.49	4.03	2.42	5.27	0.84	2.75	1.76	3.26	5.90	2.82	4.21	41.99
1901	2.44	1.02	7.68	7.82	8.27	1.68	1.84	2.87	2.61	3.02	2.06	9.71	51.02
1902	1.85	4.27	6.34	4.13	1.14	2.83	0.50	0.82	3.92	4.91	1.64	6.62	38.97
1903	4.52	4.28	9.11	5.71	1.24	4.70	2.72	4.11	1.08	4.18	3.05	2.91	47.61
1904	4.27	3.38	1.74	9.60	3.24	4.00	2.10	4.71	1.90	1.38	0.92	3.36	40.60
1905	1.80	2.12	2.63	1.55	1.07	6.38	1.72	2.72	7.65	1.74	2.56	4.91	36.85
1906	3.65	4.62	7.84	2.59	5.35	3.02	4.71	2.10	3.98	3.92	2.88	3.99	48.65
1907	2.77	1.95	2.03	2.28	2.69	1.05	1.01	0.91	9.31	1.97	6.86	8.27	41.10
1908	2.92	3.16	4.19	2.02	2.66	0.14	1.36	4.27	1.05	8.54	1.08	3.96	35.35
1909	2.80	6.05	4.78	6.02	3.48	1.94	0.35	3.16	4.38	1.21	5.50	3.10	42.77
1910	3.82	4.51	2.29	1.98	3.61	3.15	2.12	2.57	1.32	2.17	4.22	3.00	34.76
1911	3.47	2.44	3.36	3.85	1.06	1.73	5.03	4.00	2.37	2.48	6.87	3.96	40.62
1912	3.86	4.05	8.29	3.63	4.18	0.10	0.94	4.92	2.23	0.93	3.55	6.92	43.60
1913	4.98	4.10	3.14	5.01	1.70	0.75	1.83	5.09	2.86	10.50	2.66	4.56	47.18
Av.	4.44	4.41	4.93	4.12	3.83	2.90	3.14	3.79	3.57	4.58	4.45	4.61	48.77

RAINFALL AT AMHERST, MASS. Elevation, 222 feet.

1836–1875, Prof. E. S. Snell; 1876–1882, Miss S. C. Snell; 1883–1888, State Experiment Station; 1889–1913, Hatch Experiment Station.

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1836	4.21	3.83	3.13	1.98	2.59	3.45	6.02	0.96	2.28	3.02	3.49	5.80	40.76
1837	1.75	2.42	2.65	4.33	5.76	4.49	7.35	2.57	1.07	2.06	1.90	2.35	38.70
1838	2.45	1.67	1.69	2.02	3.63	4.90	2.27	3.95	6.38	4.12	5.77	0.96	39.81
1839	1.66	1.75	1.69	4.14	3.49	3.30	9.56	2.51	2.82	1.78	3.04	7.09	42.83
1840	3.15	2.03	3.18	3.98	1.91	4.60	3.34	6.82	5.20	5.04	4.61	3.15	47.01
1841	5.80	1.50	2.85	4.52	3.47	1.65	2.55	3.18	3.50	3.73	2.80	6.08	41.63
1842	1.02	3.78	2.39	2.92	2.40	3.18	1.95	7.42	3.23	2.84	3.73	3.19	38.05
1843	1.99	3.49	5.73	4.82	2.09	5.18	2.53	9.38	1.57	9.45	3.07	2.28	51.58
1844	3.44	2.18	4.12	0.57	5.59	3.00	3.81	4.93	1.84	6.49	2.12	2.49	40.58
1845	4.97	3.37	3.56	1.70	2.42	2.57	3.31	2.79	2.58	4.66	3.90	3.91	39.74
1846	2.74	2.55	4.35	1.54	4.33	3.10	3.25	2.44	0.47	2.09	4.96	3.10	34.92
1847	4.86	4.88	3.57	1.41	1.91	4.41	4.48	4.06	3.63	3.99	4.17	6.41	47.81
1848	2.92	2.60	3.03	1.55	6.18	2.58	4.72	1.53	2.49	3.15	3.09	5.54	39.38
1849	0.99	0.99	4.21	2.24	3.61	1.53	2.25	7.86	1.40	6.36	3.65	3.36	38.45
1850	4.75	3.56	1.86	3.93	8.72	2.88	6.81	6.50	4.93	3.65	2.63	5.37	55.59
1851	1.66	5.08	1.28	4.43	4.07	3.69	4.31	3.03	2.05	5.43	5.30	3.17	43.50
1852	2.42	3.35	3.26	1.71	2.30	2.54	3.38	5.19	2.48	1.76	6.43	4.88	42.70
1853	2.11	6.69	2.39	3.79	5.40	2.64	3.59	7.13	5.66	3.75	6.24	1.84	51.23
1854	2.01	4.53	3.11	8.33	3.19	1.75	3.53	0.99	5.46	2.31	7.48	2.39	45.08
1855	5.06	2.70	1.08	3.85	1.49	5.19	6.10	2.55	0.55	10.08	4.12	5.11	48.18
1856	2.48	0.79	1.12	2.51	5.31	1.92	1.96	12.13	3.47	1.40	2.85	4.19	40.13
1857	3.55	2.41	2.12	7.68	6.82	2.66	4.98	3.14	3.04	3.88	2.07	5.31	17.66
1858	3.52	1.60	0.80	3.20	2.98	4.62	6.73	4.82	4.14	3.86	2.16	3.16	41.59
1859	4.89	3.54	6.27	2.96	4.08	6.16	2.61	6.65	1.47	1.85	2.96	4.85	51.29
1860	1.21	2.98	1.58	1.28	4.57	3.57	6.13	2.68	6.12	2.18	3.52	3.84	39.66

RAINFALL AT AMHERST, MASS. — *Continued.*

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1861	4.34	3.28	3.76	5.65	4.45	2.69	5.23	4.10	2.75	4.53	3.98	2.17	46.93
1862	5.25	2.84	4.30	2.28	2.33	11.69	5.12	2.98	2.12	3.28	4.76	1.91	48.86
1863	5.05	4.43	5.60	2.33	3.59	4.09	8.64	6.11	2.16	4.04	5.28	4.87	56.19
1864	2.20	1.12	2.58	2.57	2.54	1.38	0.96	4.40	2.92	2.94	6.20	4.63	34.44
1865	3.48	2.88	5.98	2.90	7.89	2.94	3.72	1.86	0.37	4.98	2.45	3.54	42.99
1866	1.36	4.62	3.16	2.03	4.48	5.66	4.02	3.96	4.71	3.38	3.86	3.57	44.81
1867	1.32	3.65	3.12	3.79	4.61	5.67	4.00	9.16	1.11	3.85	4.31	1.51	46.10
1868	3.52	1.03	3.25	4.27	7.86	2.44	3.28	5.67	10.63	1.37	4 80	1.47	49.59
1869	3.47	4.14	5.46	1.53	5.65	5.99	2.98	1.04	4.32	11.36	2.59	4.96	53.49
1870	5.87	5.25	2.71	3.70	1.72	2.73	2.53	2.83	1.75	4.49	3 28	1.84	38.70
1871	1.96	2.91	3.99	3.09	3.82	6.58	3.52	6.45	1.30	6.09	3.51	2.67	45.89
1872	1.51	1.89	2.87	2.20	3.11	3.25	7.07	5.28	6.20	3.64	4.48	2.69	44.19
1873	5.01	2.17	3.18	1.74	3.91	1.59	2.93	3.47	4.77	6.36	3.51	3.31	41.95
1874	5.46	2.19	1.35	6.03	5.22	5.06	11.58	2.69	1.82	1 85	3.54	1.17	47.96
1875	2 90	3.62	4.20	3.33	2.19	2.89	8.15	6 17	4.65	3.89	3.97	1.03	46.99
1876	2.31	5.53	7.14	3.11	3.96	3.87	4.84	0.27	3.71	1.12	2.49	3.22	41.57
1877	2.52	0.36	6.97	2.45	1.93	4.59	6.47	2.79	0 91	6 99	5.44	1.02	42.44
1878	3.58	3.67	2.57	5.85	2.36	6.00	2.16	6.97	2.82	2.05	5.34	6.02	49.39
1879	1.75	3 49	4.98	3.85	3.32	5.37	5.75	5.89	2.59	1.80	2.35	4.85	45.99
1880	4.58	3.60	2.68	2.64	1.90	1.40	6.34	2.91	2.69	2.27	2.50	2.29	35.80
1881	4.01	1.77	4.86	1.65	4.28	3.95	1.50	2.76	2.37	4.24	4.58	6.15	42.12
1882	5.44	4 23	5.20	1.52	6.50	2.25	1.83	0.25	11.85	1.67	1.33	1.47	43.54
1883	3.24	4.03	1.70	2.18	6.20	3.99	3.69	1.57	3.17	4.31	1.80	2.99	38.87
1884	3.60	4.62	5.67	2.48	2.02	1.38	3.75	5.10	1.25	2.40	2.53	5.58	40.38
1885	3.78	3.88	0.86	3.38	3.08	3.49	2.07	8.31	0.85	3.65	5.54	3.54	42.43
1886	5.39	3.94	3.31	1.73	3.10	2.33	3.82	2 60	5.48	2.97	5.25	3.61	43.53
1887	4.57	5.05	4.05	2.98	1.13	5.09	8.93	7.75	1.22	2.10	3.35	4.11	50.33
1888	3.87	3.94	5.96	3.08	4.29	5.40	3.63	4.29	10.70	5.19	3.91	3.78	58.04
1889	1.70	1.22	1.43	2.87	4.71	5.01	9.09	2.72	3.17	4.58	6.04	3.57	46.11
1890	2.61	4.19	5.37	1.73	5.39	1.53	5.63	4.88	5.85	7.13	1.32	2.86	48.49
1891	6.75	4 23	2.99	2.66	1.97	4.75	5.28	4.18	2.66	2.94	2.99	5.40	46.80
1892	5.85	1 90	2.40	0.76	6.28	3.46	4.41	6.47	2 16	0.66	4.98	1.01	40.34
1893	3.33	5.75	3.66	4.41	5.02	3.32	2.59	3.49	2.82	4.88	2.81	4.86	46 94
1894	2.16	1 74	1.77	1.83	4 00	3.13	1.55	0.31	4.63	4.85	3.14	3.53	32.64
1895	3.87	1.05	2.71	5.56	2.07	2.76	3.87	3.46	5.04	4.77	5.36	3.94	44.46
1896	1.07	4.67	6.11	1.32	2.58	2.57	4.96	3.84	5.41	3.23	3.03	0.87	39.66
1897	3.00	2.52	3.53	2.42	4.38	6.65	14.51	4.29	1.94	0.73	5.85	7.23	57.05
1898	7.15	3.80	1.63	3.73	5.61	3.69	4.09	6.85	3.65	6.27	5.48	2.30	54.25
1899	2.80	3.56	7.13	1.79	1.28	4.13	4.89	2.00	7.90	1.84	2.17	2.00	41 49
1900	4.08	8.12	5.76	1.85	3.78	3.65	4.67	4 11	3.67	3.72	5.87	2.40	51.68
1901	1.81	0.62	5.66	5.95	6.86	0.87	3.86	6.14	4.17	3.88	3.08	7.77	50.67
1902	1.72	3.54	5.29	3.31	2.32	4.54	4.66	4.65	5.83	5.59	1.27	4.27	46.99
1903	3.28	4.27	6.40	2.30	0.48	7.79	4.64	4 92	1.66	2 72	2.04	3.95	44 45
1904	4.74	2.45	4.48	5.73	4.55	5.35	2.62	4.09	5.45	1.74	1.35	2.75	45.30
1905	3.90	1.70	3.66	2.56	1.28	2.86	2.63	6.47	6.26	2.27	2 06	3.15	38.80
1906	2.18	2.73	4.90	3.25	4.95	2.82	3.45	6.42	2.59	5.69	1.98	4.49	45.45
1907	2.73	1.92	1.82	1.98	4.02	2.61	3.87	1.44	8.74	5.00	4.50	3.89	42.52
1908	2.25	3.53	2.86	1.97	4.35	0.76	3.28	4.27	1.73	1.57	1.06	3.05	30.68
1909	3.56	5.16	3.01	5.53	3.36	2.24	2.24	3 80	4.99	1.23	1.06	2.95	39.13
1910	6.14	5.08	1.37	3.07	2.67	2.65	1.90	4.03	2.86	0.93	3 69	1.72	36.11

RAINFALL AT AMHERST, MASS.—*Continued.*

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1911	2.36	2.18	3.80	1.87	1.37	2.02	4.21	5.92	3.41	8.81	3.84	4.42	44.21
1912	2.18	3.16	5.70	3.92	4.34	0.77	2.61	3.22	2.52	2.07	4.03	4.04	38.56
1913	3.98	2.94	6.38	3.30	4.94	0.90	1.59	2.26	2.56	5.16	2.11	3.38	39.50
Av.	3.36	3.21	3.62	3.13	3.83	3.59	4.40	4.32	3.64	3.82	3.64	3.59	44.15

RAINFALL AT ANDOVER, MASS. Elevation, 250 feet.

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1782	3.0	1.5	3.8	4.3	4.5	3.4	2.6	3.2	0.2	7.4	4.0	2.9	40.8
1783	2.2	5.4	1.7	0.4	3.6	2.3	9.2	4.3	2.0	10.7	5.0	2.9	49.7
1784	6.5	1.8	2.2	7.1	3.1	2.5	4.5	7.3	4.3	2.1	11.7	7.2	60.3
1785	3.7	4.3	4.5	4.2	6.4	5.2	4.3	1.1	9.2	10.1	4.1	5.4	62.5
1786	2.5	2.3	3.7	4.3	7.2	2.1	3.6	3.7	3.4	2.0	1.8	4.9	41.5
1793	3.1	5.0	3.0	1.2	1.0	3.4	5.0	2.7	2.9	4.0	5.1	3.8	40.2
1798	3.9	2.6	5.6	4.2	5.9	4.3	2.1	2.0	3.2	9.3	2.6	2.0	47.7
1800	1.5	3.6	3.8	7.0	4.8	2.5	2.3	7.2	2.1	5.6	4.6	4.3	49.3
1803	3.5	5.0	4.2	2.2	2.7	1.7	10.9	1.5	1.3	4.5	6.5	5.4	49.4
Av.	3.3	3.5	3.6	3.9	4.4	3.0	4.9	3.7	3.2	6.2	5.0	4.3	49.0

RAINFALL AT ASHLAND, MASS. Elevation, 250 feet.
(Ashland Reservoir, Metropolitan Water Works.)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1890	2.52	3.41	7.74	2.66	5.48	2.09	2.55	4.01	5.49	10.76	1.15	5.42	53.28
1891	7.12	5.35	6.32	4.05	1.85	4.17	3.72	4.23	2.41	3.96	3.14	3.61	49.93
1892	5.70	3.08	4.11	0.81	5.60	2.77	4.24	4.40	3.09	1.06	5.79	1.11	41.76
1893	2.92	8.24	3.66	3.82	6.28	2.29	2.23	5.45	1.67	4.05	2.16	4.78	47.55
1894	3.95	3.91	1.46	3.55	4.10	1.20	2.69	2.12	2.49	5.49	3.42	4.81	39.19
1895	4.24	1.34	3.01	5.12	2.10	2.31	4.91	4.30	2.41	8.93	7.67	3.50	49.84
1896	2.30	7.02	6.10	1.29	2.32	3.30	2.88	2.05	8.05	3.69	3.12	2.08	44.20
1897	3.87	2.97	3.89	2.79	4.28	4.47	5.55	4.07	3.36	0.53	6.36	5.35	47.49
1898	7.11	4.70	2.40	4.59	3.40	2.25	4.65	7.54	2.81	6.72	6.64	3.28	56.09
1899	4.29	4.99	7.15	1.82	1.72	2.34	3.17	1.49	4.13	2.84	1.96	1.69	37.59
1900	4.91	9.12	6.17	2.43	4.06	3.27	2.50	2.45	3.31	3.65	5.97	2.81	50.68
1901	1.97	1.74	6.73	8.34	6.72	1.39	6.37	4.82	3.62	2.62	2.91	10.30	57.53
1902	2.34	6.34	4.72	3.79	1.62	3.25	3.05	2.79	3.99	4.32	1.43	6.32	43.96
1903	3.83	4.02	6.58	2.91	0.67	8.05	2.86	3.69	1.46	4.78	1.62	3.19	43.66
1904	4.63	3.06	2.76	8.99	2.70	2.27	1.57	3.81	6.08	1.69	1.73	3.11	42.40
1905	5.28	2.00	3.10	2.48	1.46	4.46	4.96	2.70	6.97	1.52	2.06	3.94	40.93
1906	2.46	2.94	6.45	2.77	5.67	3.76	3.47	3.24	3.42	3.51	2.64	4.53	44.86
1907	3.16	2.13	1.86	3.39	3.53	2.91	2.03	1.05	8.07	4.07	6.05	4.58	42.83
1908	3.43	4.60	3.84	1.81	5.94	0.90	3.48	4.30	0.89	2.53	0.90	3.07	35.69
1909	3.98	5.75	4.30	3.98	2.34	3.21	1.24	2.74	4.59	1.13	3.38	4.01	40.65
1910	5.45	4.95	0.91	2.61	1.16	5.06	2.37	2.86	2.58	1.71	4.04	2.64	36.34
1911	2.80	2.74	3.57	2.96	1.05	2.37	2.98	5.15	2.67	3.45	4.61	3.67	38.02
1912	2.99	2.64	6.66	4.27	4.65	0.49	3.84	2.64	1.56	2.32	3.32	4.99	40.37
1913	3.40	2.81	5.92	4.34	3.92	2.14	2.23	3.49	3.56	5.31	2.65	3.14	42.91
Av.	3.94	4.16	4.56	3.57	3.44	2.95	3.31	3.56	3.69	3.78	3.53	4.00	44.49

RAINFALL AT ATTLEBOROUGH, MASS. Elevation, 100 feet.
(Water Works Pumping Station.)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1896	1.92	6.17	4.75	0.98	2.12	3.78	1.73	2.84	8.75	3.11	3.57	1.11	40.83
1897	4.29	2.74	1.78	2.59	4.81	3.91	5.58	3.74	1.84	0.61	6.75	4.85	43.49
1898	3.21	6.18	2.47	6.75	4.31	1.33	8.25	7.01	2.79	7.57	5.77	2.07	57 71
1899	5.61	4.47	8.03	2.01	2.01	3.55	4.60	2.05	10.21	1.16	3.19	2.21	49.10
1900	4.26	8.99	5.73	1.86	6.17	3.16	2.63	2.09	4.41	3.25	4.44	2.92	49.91
1901	1.88	0.76	8.44	8.14	7.19	0.60	3.51	2.35	4.29	3.20	2.55	8.21	51.12
1902	2.23	6.62	5.40	3.37	1.09	4.47	4.02	2.87	3.67	4.83	1.67	6.06	46.30
1903	4.80	6.17	8.27	3.71	0.36	6.25	4.13	4.06	1.25	3.23	1.65	3.16	47.04
1904	5.09	3.72	3.15	9.80	2.20	1.28	1.66	4.13	7.04	2.33	2.09	3.80	46.29
1905	4.01	3.06	2.05	3.03	1.33	5.63	1.70	3.41	7.15	2.23	1.95	5.49	41.01
1906	3.40	3.42	5.45	2.69	5.76	2.69	7.37	3.19	4.36	4.80	2.40	2.28	47.81
1907	5.53	3.04	2.16	4.00	4.08	2.40	1.48	1.17	9.45	1.60	6.65	4.48	46.04
Av.	3.85	4.61	4.80	4.08	3.45	3.25	3.89	3.24	5.44	3.16	3.56	3.89	47.22

RAINFALL AT BARNSTABLE, MASS. Elevation, 31 feet.
(Hyannis)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1892	4.16	2.14	6 14	2.27	5.36	1.50	1.24	2.08	2.06	2.07	8.33	2.63	39.98
1893	2.47	5.82	5.90	4.86	4.05	5.59	3.08	5.39	3 01	1.47	2 26	6.56	50.46
1894	5.77	3.81	1.61	5.05	3.74	0.43	0.62	1.48	2.94	6.01	3.91	5.44	40.81
1895	3.08	1.39	4.23	1.73	3 63	1.05	2.85	3.89	1.19	2.77	4.42	3.75	33.98
1896	2.48	3.34	6.08	0.84	2.83	3.23	4.35	4.20	5.38	6.02	3.87	3.00	45.62
1897	2.71	2.23	3.01	5.57	2.89	1.97	4 44	4.37	1.05	1.74	7.96	3.52	41.46
1898	4.81	4.27	3.74	5.78	6.41	1.22	3.85	4.46	0.84	6.62	8.41	2.59	53.00
1899	3.66	5.87	8.33	1.55	0.91	5.10	3.52	1.88	2.58	2.39	1.22	1.27	38.28
1900	5.55	4.74	3.01	3.43	2.76	1.12	1.22	1.36	3.47	4.31	5.10	2.58	38.65
1901	3.14	1.20	6.86	5.70	9.64	1.27	3.40	2.18	4.23	0.86	2.20	8.48	49.16
1902	2.12	4.17	6.61	2.68	1.13	5.11	4.98	0.54	3.04	5.89	2.68	6.51	42.46
1903	4.18	4.48	7.25	3.72	0.96	3.25	2.28	4.10	1.85	5.77	6.11	3.17	47.12
1904	5.12	3.43	2.46	6.25	4.29	5.03	4.78	4.19	1.44	2.23	2.42	4.33	45.97
1905	4.42	2.01	3.26	1 33	1.75	5.78	1.94	4.14	5.63	1.87	3.18	4.00	39.31
1906	4.80	4.08	8.45	2.28	4.47	2.20	6.07	1.07	2.91	1.91	1.78	3.78	43.80
1907	4.07	2.54	2.66	3.49	5.13	1.68	0.62	1.61	4.96	1.92	5.88	5.19	39.75
1908	3.82	3 03	3.30	2.04	2.87	1.71	3 43	4.82	1.20	8.86	2.02	4.29	41.39
1909	5.12	5.56	3.81	4.35	2.57	1.31	0.55	2.26	4.61	3.61	6.76	2.66	43.17
1910	6.78	4.23	2 45	2.92	3.99	2.56	1 87	3.17	1.82	2.92	3.86	3.54	40.11
1911	3.46	3.16	3.22	4.99	0.76	6 70	3.72	7.12	3.25	2.47	5.72	3.28	47.85
1912	4.44	3.14	6.16	3.31	5.44	0.46	3.21	5.45	2.50	1.16	3.13	7.44	45.87
1913	5.49	4.00	2.89	5.46	2.12	0.87	0.92	6.91	3.07	8.05	1.78	3.38	44.94
Av.	4.17	3.57	4.61	3.62	3.53	2.69	2.73	3.48	2.86	3.68	4.23	4.15	43.32

RAINFALL AT BEDFORD, MASS. Elevation, 170 feet.

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1893	3.11	5.48	3.03	2.91	5.16	2.95	1.79	6.00	1.73	3.36	1.95	4.22	41.69
1894	2.70	2.61	1.07	2.41	4.04	1.83	3.08	1.62	2.42	3.96	2.58	2.68	31.00
1895	3.59	0.97	2.44	4.10	1.42	2.45	2.77	3.18	2.25	7.21	6.64	2.07	39.09
1896	2.17	5.45	5.63	1.32	2.22	2.44	2.95	2.64	6.73	3.15	3.18	1.77	39.65
1897	4.09	2.52	3.75	2.26	4.39	3.88	4.50	3.45	2.99	0.35	5.55	4.15	41.88
1898	5.32	4.25	1.96	5.45	2.94	2.91	4.96	9.15	2.64	7.06	5.64	2.65	54.93
1899	3.51	3.82	6.06	1.71	1.22	3.90	3.35	3.43	3.73	1.76	2.57	0.99	36.05
1900	5.03	8.05	5.17	2.48	4.22	2.12	2.14	1.93	4.22	3.38	5.05	1.54	45.33
1901	1.57	1.18	5.10	6.66	6.92	1.49	6.00	3.05	2.41	2.69	2.58	8.00	47.65
1902	1.67	4.04	5.55	3.53	2.66	1.81	3.11	4.66	4.54	5.05	0.82	5.60	43.04
1903	3.16	3.03	5.98	3.18	0.63	8.31	2.87	2.71	1.71	4.66	1.48	2.67	40.39
1904	3.24	2.36	1.81	7.39	3.77	4.07	1.78	3.27	4.97	1.69	1.69	2.48	38.52
1905	4.38	1.08	2.89	2.34	0.91	4.86	1.81	4.35	8.32	1.42	1.84	4.05	38.25
1906	2.32	2.64	5.60	2.92	4.51	3.17	5.06	3.47	2.09	2.27	2.02	3.79	39.86
1907	2.88	1.56	1.86	2.66	3.24	3.45	2.72	1.22	8.33	4.20	5.24	3.73	41.09
1908	2.60	4.20	2.66	1.46	3.51	0.98	2.62	5.33	0.77	2.60	1.06	2.67	30.46
1909	3.77	4.75	3.17	4.63	2.25	2.53	3.52	2.26	3.70	1.19	2.93	3.08	37.78
1910	4.10	4.00	1.36	2.64	1.43	2.87	1.65	2.17	2.88	1.29	3.54	2.19	30.12
1911	2.45	1.66	3.21	1.80	1.05	3.46	3.86	4.50	3.04	3.04	3.90	3.32	35.29
1912	2.69	1.90	5.60	3.76	4.55	0.19	6.04	2.19	2.66	3.07	3.14	4.72	40.51
1913	2.28	2.75	3.90	3.63	4.22	1.29	1.86	2.60	2.97	5.98	2.07	2.23	35.78
Av.	3.17	3.25	3.71	3.30	3.11	2.90	3.26	3.48	3.58	3.30	3.12	3.27	39.45

RAINFALL AT BELCHERTOWN, MASS. Elevation, 440 feet.

(Springfield Water Works.)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1894	3.96	3.94	1.47	2.12	2.95	1.05	1.64	0.76	3.56	3.77	3.86	3.01	32.09
1895	3.27	1.83	2.60	3.77	1.70	4.08	4.70	3.58	4.07	4.08	6.79	2.15	42.62
1896	1.48	5.45	5.97	1.92	1.81	3.68	5.00	3.13	5.39	3.54	2.74	1.45	41.56
1897	3.99	2.19	3.97	2.59	5.13	4.86	9.86	4.95	1.29	0.64	5.85	4.95	50.27
1898	5.77	4.84	2.38	4.53	4.46	2.55	2.91	7.29	2.40	7.10	6.22	2.14	52.59
1899	4.12	3.98	6.58	2.27	1.38	5.98	5.20	1.70	4.67	2.33	2.76	2.14	43.11
1900	3.23	8.27	6.24	1.79	3.98	3.00	5.06	3.67	2.81	3.80	6.54	2.70	51.09
1901	1.49	0.92	6.01	4.13	5.09	0.93	2.81	6.53	3.39	4.70	1.56	6.83	44.39
1902	1.80	1.18	5.77	1.19	2.24	3.05	4.92	4.33	4.90	4.87	1.02	6.32	41.59
1903	3.40	4.25	5.92	2.30	1.57	7.20	4.19	4.51	2.99	2.85	2.64	3.35	45.17
1904	3.97	2.81	3.15	6.04	4.57	5.45	3.34	4.87	4.67	1.50	1.53	2.23	44.13
1905	3.37	1.39	3.42	2.86	1.23	1.80	1.95	2.17	2.40	0.79	2.16	2.56	26.10
1906	2.67	2.46	5.28	2.99	6.16	6.81	6.51	4.43	3.04	5.49	2.36	1.44	49.64
1907	2.55	2.12	1.76	2.67	3.87	2.78	3.00	1.28	9.87	5.17	4.29	4.17	43.53
1908	2.75	3.41	2.99	2.24	4.01	2.19	4.68	6.92	0.96	1.61	0.98	2.53	35.27
1909	3.62	5.49	3.19	6.10	2.47	2.24	1.59	2.53	4.72	1.05	2.21	4.64	39.85
Av.	3.22	3.41	4.17	3.09	3.29	3.60	4.21	3.92	3.82	3.33	3.34	3.29	42.69

RAINFALL AT BOSTON, MASS. Elevation, 30 feet.

1818–1822, Dr. Enoch Hale; 1823–1865, Jonathan P. Hall; 1866–1884, Superintendent of Sewers; 1885–1890, Water Works Pipe Yard, 710 Albany Street; 1891–1894, Street Department, South Yard, 680 Albany Street; 1895–April, 1898, Water Works Pipe Yard, 710 Albany Street; May, 1898–1907, Water Works Pipe Yard, Gibson Street, Dorchester; 1908–1913, inclusive, Main Drainage Yard, 759 Massachusetts Avenue, corner Albany Street.

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1818	2.64	3.49	4.05	6.15	5.96	3.47	4.08	0.46	7.81	2.11	1.91	0.86	42.99
1819	0.70	2.27	6.21	3.74	3.06	3.56	2.02	4.38	5.29	1.40	1.22	1.63	35.48
1820	3.12	4.25	4.90	0.45	5.08	3.42	4.19	5.15	2.43	5.39	3.00	2.80	44.18
1821	1.41	4.42	2.53	4.90	4.84	2.79	2.35	1.58	4.73	2.29	3.12	1.93	36.89
1822	1.29	2.34	2.02	2.99	0.78	3.54	4.32	1.20	2.15	2.53	2.58	1.46	27.20
1823	3.00	4.57	7.72	2.21	6.40	0.93	5.74	1.98	1.95	3.95	1.92	6.93	47.30
1824	3.95	5.99	1.81	4.72	1.43	1.60	0.88	3.68	6.43	1.01	1.72	2.80	36.02
1825	2.79	3.43	4.70	0.37	1.36	4.77	1.24	5.62	2.66	3.21	0.81	4.38	35.34
1826	2.55	1.48	3.81	1.50	0.25	3.85	2.90	12.10	3.03	3.80	2.31	3.56	41.14
1827	3.92	2.97	2.51	4.75	5.34	2.56	2.59	4.88	4.81	5.28	5.71	3.59	48.91
1828	2.15	2.79	1.84	2.00	4.67	1.59	4.58	0.37	3.82	2.79	5.55	0.26	32.41
1829	4.93	5.62	4.30	3.45	2.71	1.64	6.98	4.95	2.62	1.65	5.74	2.26	46.85
1830	2.36	1.63	3.51	1.21	3.93	3.46	4.90	2.64	5.65	2.38	5.32	5.96	42.95
1831	4.44	3.68	3.07	6.97	3.65	4.32	5.53	5.57	3.83	4.42	3.20	2.93	51.61
1832	4.47	3.74	2.65	5.56	7.27	0.50	3.41	6.14	2.07	2.46	3.57	4.85	46.69
1833	2.96	2.53	2.71	2.30	1.03	3.23	2.01	0.82	2.88	6.00	5.53	5.86	37.86
1834	1.39	1.13	0.96	2.93	6.33	3.09	7.71	2.47	3.71	4.62	2.90	2.36	39.60
1835	3.25	1.37	4.27	4.54	2.07	2.74	9.07	2.89	1.31	1.87	2.08	2.40	37.86
1836	8.84	3.57	2.90	1.58	1.85	4.33	2.12	1.53	0.54	4.04	5.43	4.13	40.86
1837	4.10	4.14	3.02	3.07	5.79	2.98	1.80	1.67	0.56	1.58	2.35	2.46	33.52
1838	3.07	2.77	3.09	2.62	3.32	2.55	1.20	4.26	9.87	5.02	3.95	0.80	42.52
1839	0.98	3.11	1.18	7.73	4.27	2.25	3.32	5.70	2.00	2.50	1.71	6.35	41.10
1840	3.12	2.57	4.55	4.60	2.23	2.78	2.93	4.00	2.12	4.48	11.63	4.15	49.16
1841	6.00	1.60	3.50	8.82	1.90	1.95	2.10	4.20	2.86	3.80	4.55	5.77	47.05
1842	0.80	3.20	3.35	3.50	2.90	5.30	1.82	4.44	3.25	0.80	4.45	5.30	39.11
1843	2.20	6.08	6.17	3.88	1.60	4.61	2.15	6.88	0.98	4.82	3.40	3.92	46.69
1844	3.68	2.42	6.00	0.20	2.72	1.40	2.17	2.62	3.53	5.80	3.15	3.85	37.54
1845	4.58	4.25	3.83	1.23	2.82	2.05	3.28	1.82	2.23	4.00	10.25	5.98	46.32
1846	3.12	2.95	2.73	1.23	2.02	2.25	2.51	1.80	1.30	1.35	4.17	4.52	29.95
1847	3.28	4.70	4.77	2.20	2.03	4.09	2.65	6.45	6.64	1.05	5.12	3.95	46.93
1848	2.30	3.90	4.05	1.40	6.30	1.73	1.35	3.10	3.55	5.10	2.25	5.95	40.98
1849	0.35	1.15	7.35	0.90	3.10	1.45	0.85	6.25	1.25	8.10	5.50	4.05	40.30
1850	4.59	2.52	5.32	4.82	6.63	2.77	2.70	5.30	7.15	2.10	3.32	6.76	53.98
1851	1.30	4.20	3.88	9.37	3.31	1.80	3.09	1.27	3.50	4.43	5.51	2.65	44.31
1852	4.85	2.85	4.45	10.18	1.95	2.35	3.28	7.63	1.65	2.19	3.47	3.09	47.94
1853	2.44	5.30	2.27	3.78	5.63	0.30	3.64	9.40	3.80	3.92	4.43	3.95	48.86
1854	2.91	4.87	2.84	6.63	4.33	2.47	3.70	0.58	3.86	2.08	6.80	4.64	45.71
1855	7.22	4.67	1.18	4.28	1.20	3.09	4.15	1.46	1.13	4.61	5.27	5.93	44.19
1856	5.32	0.80	1.33	4.37	7.10	2.90	4.02	11.11	4.90	2.70	3.33	4.28	52.16
1857	5.36	2.45	3.09	10.83	5.57	2.02	5.53	7.18	2.56	4.50	2.52	5.26	56.87
1858	3.28	2.30	2.18	5.18	3.89	8.09	4.56	7.03	5.02	3.03	3.38	4.73	52.67
1859	5.93	4.05	7.64	3.36	3.63	7.89	1.58	4.72	4.40	3.28	3.75	6.47	56.70
1860	1.89	3.85	2.19	1.73	2.35	8.01	5.90	4.30	7.35	2.66	5.37	5.86	51.46
1861	6.04	3.57	7.48	5.89	2.97	3.64	2.76	6.04	1.77	2.66	4.90	2.35	50.07
1862	8.30	3.29	4.70	1.97	2.70	6.78	7.33	4.20	5.61	4.85	8.32	3.01	61.06
1863	4.51	4.54	6.42	9.08	2.82	2.56	12.38	5.64	3.12	3.83	6.48	6.34	67.72
1864	3.87	1.43	11.75	4.72	3.31	1.47	1.90	4.17	2.60	4.80	4.00	5.28	49.30

RAINFALL AT BOSTON, MASS. — *Continued.*

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1865	4.47	5.08	4.83	2.57	6.90	2.83	4.26	1.42	0.62	6.21	4.46	4.18	47.83
1866	3.73	5.28	4.70	2.03	5.04	3.41	5.42	3.87	5.90	2.72	3.74	4.86	50.70
1867	6.06	6.55	6.12	2.52	4.11	2.74	4.76	10.78	0.44	6.76	2 32	2.48	55.64
1868	6.09	1.88	5 04	6.94	10.38	3.79	1.10	7.53	11.95	1.78	5.31	2.32	64.11
1869	4.03	9.98	8.74	2.05	6.88	4.44	3.30	2.19	5.18	6.71	3.74	9.04	66.28
1870	8.16	7.03	4.88	8.42	2.58	7.59	4.01	1.57	0.67	6.80	4.40	3.62	59.73
1871	2.77	3.72	4.68	4.23	5.69	5.67	2.87	3.31	1.37	5.51	5.38	3.13	48.33
1872	2.43	2.68	3.98	3 24	3.95	4.81	4.48	10.48	7.37	4.98	4.64	5.00	58.04
1873	6.69	3.74	4.54	3.81	4.92	0.65	3.25	6.46	2.78	5.43	7.34	5.33	54.94
1874	4.30	4.02	1.64	8.36	3.72	2.91	2.70	6.48	1.66	1.02	2.58	1.70	41.09
1875	3.24	3.62	5.76	4 46	3.89	7.73	3 84	3.50	3.32	5 06	5.62	0.97	51.01
1876	1.89	5.24	8.25	5.61	3.14	2.16	6.50	1.82	3.62	2.13	9.82	5.01	55.19
1877	4.03	1.20	9.08	3.82	3.58	3.05	2.58	5.68	0.53	8.19	8.36	1.05	51.15
1878	7.30	6.08	5.37	5.88	0 92	2.06	3.63	6.50	2.32	6.10	7.11	5 62	58.89
1879	2.74	3.54	4.31	6.97	1.16	5.62	3.43	6 45	1.86	0.80	3.53	4.64	45.05
1880	3.23	4.73	3.85	3.28	1.86	0.63	7.52	2.87	2.30	3.41	2 07	3.14	38.89
1881	5.59	5.15	6.94	2.36	3.59	7.01	3.51	1.17	2.52	2.86	4.42	4.10	49.22
1882	4 66	6.35	3.57	2.61	5.80	1.74	4.01	1.69	11.47	2.30	1.74	2.48	48.42
1883	4.04	3.55	2.14	2.95	3.94	2.57	2.51	0.34	1.38	6.34	2.07	3.73	35.56
1884	5.71	7.19	6.25	4.88	3.32	4.21	5.33	5.30	0.23	3.34	3.19	4.91	53.86
1885	5.21	2.88	1.21	3.62	4.35	3.38	1.40	7.22	1.60	5.67	5.53	2.00	44.07
1886	7.04	7.38	3.76	2.52	3.96	1.30	2.09	3.98	2.94	3.06	3.73	4.71	46.47
1887	5.93	4.37	5.27	4.35	1.69	2.15	3.92	3.21	1.24	2.84	2.59	3.59	41.15
1888	3 34	2.93	5.76	2.46	6.40	2.71	2.14	7.18	8.86	4.71	8.58	5.40	60.47
1889	6.18	2.00	2.42	3.98	4.93	4.18	8.44	4.46	4.28	4.19	5 83	2.36	53.25
1890	2.54	3.05	6.49	2.79	5.42	2.53	1.75	2.99	6.12	7.92	1.11	3.82	46.53
1891	6.63	5.24	4 03	2.65	2 01	3.21	3.20	3.51	2.99	6 67	2.14	3.78	46.06
1892	6.58	1.41	2.61	0.81	6.17	3.10	1.36	5.65	2.45	2.44	4.66	1.15	38.39
1893	2.70	6.04	2.84	3.31	6.32	2.35	2.08	7.59	1.55	3.51	2.21	5.14	45.64
1894	3.28	2.98	0.99	3.50	4 03	0.83	3 22	3.18	2.24	5.22	3.19	4.34	37.00
1895	3.38	0.54	2.92	4.84	2.68	1.47	3.42	3.28	1.06	8.05	6.50	1.78	39.92
1896	2.03	4.47	4.93	1.14	1.42	2.53	2.07	1 72	7.53	2.98	3.78	1.65	36.25
1897	3.06	2.92	2.64	3.08	3.55	4.20	4.38	4.51	3.29	0 30	6.74	5.14	43.81
1898	4.44	4.66	1.36	6.91	4.03	1.80	6.07	5.68	1.93	7.85	4.97	2.53	52.23
1899	5.46	3.73	6.97	1.41	1.27	2.84	4.02	1 40	6.35	2.61	3 20	1.42	40.68
1900	3.37	7.17	5.09	2.10	5.82	2.11	2.67	2.07	4.49	4.26	5 89	2.09	47 13
1901	1.41	0.89	4.96	5.59	5.96	1.54	7.09	3.04	4 04	3.94	3.21	6.98	48.65
1902	1.54	2.79	5 97	2.18	1.61	2.76	3.53	3.26	2.33	4.94	1.53	5.97	38.41
1903	3.94	3.24	6.43	3.84	0.38	7.32	3 77	2.97	2.62	4.03	1.19	2 21	41.94
1904	5.81	2.67	2.56	9.28	3.11	2.07	1.41	2 41	5.01	2.18	2.02	2.83	41.36
1905	4.90	1.82	2.41	3.00	1.67	4.81	2.03	2.40	4.78	1.32	2.09	3.61	34.84
1906	2.73	3.14	6.37	2.30	5 04	1.74	5 45	0.78	2.92	3.43	3.63	2.90	40.43
1907	4.33	2.31	1.86	3.35	2.73	2.34	0.82	1.25	8.24	2.50	6.21	4.25	40.19
1908	2.82	4.14	3.47	1.62	4 13	2.06	3.64	4.24	0.60	3.70	1.37	2.57	34.36
1909	4.58	4.99	3.79	6.19	3.04	3.98	0.86	3.41	5.67	1.18	4.52	3.60	45.81
1910	4.79	4.17	1.02	3.59	3.56	5.37	2.03	1.47	2.06	1 32	4.38	2.05	35.81
1911	2.65	2.73	2.96	2.59	0.54	4.09	4.97	5.72	4.00	2.53	2.91	2.96	38.65
1912	3.16	2.38	4.42	3.46	4.33	0.28	4.42	2.06	1.69	1.21	2.75	4 88	35.04
1913	2.44	3.23	4.97	5.05	3.23	0.55	2 15	2.79	2.41	6.88	2.41	3.26	39.37
Av.	3.89	3.66	4.19	3.94	3.70	3.15	3.59	4.11	3.53	3.76	4.14	3.80	45.46

RAINFALL AT BOSTON, MASS. Elevation, 100 feet.
(Beacon Hill Reservoir.)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1876	1.84	4.31	6.62	3.10	3.33	2.05	6.77	1.50	3.30	1.96	8.51	3.29	46.58
1877	...	...	...	...	...	...	...	...	...	...	...	...	...
1878	5.52	5.51	4.59	5.77	0.83	2.03	4.34	6.60	2.12	5.19	6.32	4.87	53.69
1879	2.46	2.50	3.64	5.57	1.21	5.66	2.41	5.02	1.99	1.38	2.97	3.60	38.41
1880	2.51	4.08	2.85	2.59	1.58	0.50	6.03	2.96	1.68	2.96	2.30	2.55	32.59
Av.	3.08	4.10	4.42	4.26	1.74	2.56	4.89	4.02	2.27	2.87	5.03	3.58	42.82

RAINFALL AT BOSTON, MASS. Elevation, 25 feet.
(Fort Independence, Boston Harbor.)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1851	1.53	4.23	1.80	8.55	3.57	**1.94**	1.60	1.44	1.24	3.95	4.40	1.28	35.53
1852	3.50	1.32	1.26	4.00	1.20	2.71	1.92	5.35	1.60	1.42	2.94	3.00	30.22
1853	2.16	3.48	1.16	2.77	6.31	2.55	4.04	4.70	3.90	2.74	4.52	2.71	41.04
1854	2.50	3.36	2.55	5.40	4.28	2.00	4.44	0.50	3.34	1.47	5.57	3.23	38.64
1855	6.34	3.20	1.16	2.72	1.62	2.18	3.57	1.68	1.52	5.19	2.92	3.68	35.78
1856	5.27	1.28	1.47	3.36	5.13	2.65	4.38	9.16	4.20	**2.50**	**2.75**	**3.57**	45.72
1857	2.29	1.67	2.60	6.40	4.92	1.77	4.65	5.91	1.76	4.22	1.70	4.48	42.37
1858	0.68	1.42	1.43	4.43	2.95	5.60	2.80	5.16	3.44	1.75	3.37	4.64	37.67
1859	4.99	3.18	5.39	2.51	3.41	7.79	1.02	3.76	3.73	2.45	2.45	5.97	46.65
1865	**3.78**	**4.45**	**4.35**	**2.43**	**6.12**	**2.67**	**2.92**	**2.12**	**0.66**	**5.31**	3.35	1.67	39.83
1866	0.82	3.26	2.85	**2.14**	3.55	**2.82**	**5.49**	**3.21**	3.56	1.43	3.61	3.52	36.26
1867	1.10	4.60	4.20	2.45	3.60	1.70	4.11	9.80	0.53	4.50	1.65	1.45	39.69
1868	2.30	0.90	1.70	5.10	9.00	2.37	2.15	6.25	8.10	1.45	4.40	1.85	45.57
1869	2.55	7.10	4.50	1.40	5.75	3.00	2.90	2.00	3.01	5.85	2.40	4.20	44.66
1870	6.25	4.50	3.25	6.65	1.88	6.36	2.46	1.15	0.54	4.28	2.84	1.78	41.94
1871	1.32	2.55	2.78	2.50	3.30	4.73	2.18	3.78	1.04	6.04	1.98	3.67	35.87
1872	1.76	1.30	7.68	1.75	3.95	3.95	6.49	6.40	5.85	4.80	1.51	3.95	52.39
1873	5.29	2.70	3.30	2.15	2.74	1.55	3.95	5.17	2.01	2.18	6.02	4.55	41.61
1874	2.94	2.08	3.09	6.85	3.45	1.80	2.36	5.82	1.72	0.67	8.45	5.15	44.38
1875	6.40	2.25	9.75	7.20	10.80	8.35	11.50	7.85	2.45	2.15	3.35	**1.04**	73.09
1876	1.40	4.45	6.50	**4.48**	2.00	**1.73**	5.50	1.63	3.25	1.60	9.90	2.80	45.24
1877	4.03	1.00	8.15	3.20	2.95	1.55	1.21	4.64	0.20	5.60	6.70	0.70	39.93
1878	6.90	4.30	4.20	5.80	**0.58**	**2.61**	4.70	**9.16**	4.30	4.40	**6.16**	4.60	57.71
1879	**2.12**	3.10	4.58	3.56	1.37	**4.90**	3.25	5.75	4.50	2.05	**3.03**	**3.53**	41.74
Av.	3.26	2.99	3.74	4.08	3.93	3.30	3.73	4.68	2.77	3.25	4.12	3.21	43.06

RAINFALL AT BOSTON, MASS. Elevation, 25 feet.
(Fort Warren, Boston Harbor.)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1871	0.82	1.07	2.75	2.05	1.75	3.60	1.82	3.45	0.70	5.29	2.49	3.52	29.31
1872	1.65	1.57	2.80	1.25	7.00	3.30	3.70	8.20	4.00	5.70	2.55	13.91	55.63
1873	7.25	14.00	11.20	8.15	7.00	1.75	3.30	5.44	1.27	3.69	1.90	1.35	66.30
1874	2.80	3.20	1.98	9.85	3.30	3.93	2.50	9.00	1.30	1.10	1.80	**3.42**	44.18
1875	2.30	3.12	4.60	5.10	3.80	**8.04**	2.75	4.20	**2.88**	2.50	3.25	1.20	43.74
1876	1.11	2.76	4.50	1.88	1.92	1.98	4.72	1.08	2.36	0.88	9.38	3.20	35.77
1877	2.70	0.80	10.40	2.32	**3.26**	2.50	3.14	3.56	0.38	4.52	3.52	0.28	37.38
1878	3.12	2.38	1.68	4.11	0.72	1.04	2.46	2.70	**3.31**	4.04	3.02	3.10	31.71
1879	1.02	2.44	1.94	2.88	0.56	3.63	3.25	5.74	0.52	0.60	2.50	2.04	27.12
1880	3.16	1.94	1.05	1.56	1.50	0.81	3.93	3.40	0.94	1.44	1.72	1.66	23.11
Av.	2.59	3.33	4.29	3.92	3.08	3.06	3.16	4.68	1.76	2.98	3.21	3.37	39.43

RAINFALL AT BOSTON, MASS. Elevation, 25 feet.
(Thompson's Island, Boston Harbor.)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1906	2.88	2.19	2.33	1.66	4.69	2.15	4.95	1.28	2.56	3.21	2.43	3.49	33.82
1907	2.28	1.72	0.94	2.79	2.88	1.92	0.88	0.74	6.90	2.29	4.77	4.53	32.64
1908	0.90	2.49	2.25	1.09	2.47	1.68	3.01	2.93	0.49	2.55	0.76	1.44	22.06
1909	3.08	2.49	1.79	2.89	1.71	2.60	0.73	2.35	3.40	0.97	3.09	2.26	27.36
1910	3.91	3.07	1.23	1.46	0.79	3.13	2.03	1.28	1.33	1.13	2.28	0.98	22.62
1911	1.55	3.47	2.25	1.96	0.34	3.81	3.76	4.72	2.81	3.05	3.35	2.69	33.76
1912	3.20	1.33	2.25	3.93	3.50	0.29	5.32	2.41	1.34	1.03	2.33	3.98	30.91
1913	1.55	1.94	2.59	5.29	2.96	0.93	1.70	2.55	2.82	6.43	2.32	2.21	33.29
Av.	2.42	2.34	1.95	2.63	2.42	2.06	2.80	2.28	2.71	2.58	2.67	2.70	29.56

RAINFALL AT BOSTON, MASS. Elevation, 60 feet.
(Charlestown.)
(Joseph Barrell, Esq.)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1792	0.55	1.50	5.21	3.14	2.44	2.17	1.83	1.69	3.48	2.02	6.32	0.13	30.48
1793	3.59	3.39	5.91	1.79	2.84	2.02	1.21	1.09	2.86	2.27	4.25	1.12	32.34
1794	5.67	1.42	4.07	0.83	0.83	2.54	2.13	4.04	1.78	4.18	1.36	2.26	31.11
1795	2.68	1.05	2.91	7.11	3.61	2.09	5.36	6.08	5.26	4.09	2.20	3.20	45.64
1796	2.39	2.21	2.53	0.72	3.92	1.22	2.28	1.46	4.80	2.00	1.02	1.22	25.77
1797	2.67	4.33	5.24	3.81	3.40	2.09	2.96	5.09	1.30	5.14	3.05	2.10	41.18
1798	1.53	2.70	3.48	2.98	5.61	3.83	3.81	0.86	1.91	7.71	1.88	2.01	38.31
1799	1.93	1.17	2.57	2.80	4.65	4.36	2.53	2.84	2.46	3.24	1.55	3.39	33.49
1800	0.90	3.13	1.68	7.46	6.10	1.04	1.77	6.94	4.62	4.43	3.62	3.74	45.43
1801	4.06	3.12	6.53	3.45	2.44	2.73	5.16	3.83	1.72	0.46	4.57	2.53	40.60
1802	2.67	0.45	4.82	1.07	6.30	1.81	2.65	3.79	3.05	3.22	1.66	3.31	34.80
Av.	2.60	2.23	4.09	3.20	3.83	2.36	2.88	3.43	3.02	3.52	2.86	2.27	36.29

RAINFALL AT BROCKTON, MASS. Elevation, 200 feet.
(City Hall.)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1894	2.78	2.88	1.34	2.45	3.32	0.68	2.08	1.26	2.85	6.18	4.37	5.24	35.43
1895	3.46	0.70	3.17	4.77	2.51	2.33	4.54	3.81	4.53	5.37	7.54	2.59	45.32
1896	1.69	3.68	5.68	1.19	1.79	3.53	1.57	2.14	6.26	2.82	4.09	2.08	36.52
1897	3.18	2.08	2.33	3.07	4.41	4.55	4.57	3.89	1.96	0.60	6.19	3.65	40.48
1898	3.30	4.85	2.09	6.15	4.06	1.35	5.98	6.77	1.99	7.77	6.23	1.94	52.48
1899	4.86	3.26	5.59	1.14	1.72	2.88	4.52	1.40	9.56	2.17	2.06	1.15	40.31
1900	3.91	5.12	3.73	1.70	5.54	5.79	2.75	1.54	4.55	3.48	4.28	2.11	44.50
1901	1.64	0.73	7.05	5.75	6.49	1.64	5.04	2.22	4.30	3.29	2.05	7.65	47.85
1902	1.89	3.13	5.59	2.48	1.17	4.35	2.12	2.92	3.93	3.61	1.00	4.87	37.06
1903	3.76	4.35	7.06	3.97	0.75	4.75	2.42	3.38	0.91	3.91	1.87	3.16	40.29
1904	4.52	3.55	2.29	8.00	2.85	2.43	2.81	2.69	5.35	1.76	1.57	3.01	40.83
1905	3.14	1.48	2.05	3.14	0.97	4.40	1.64	2.49	5.28	1.74	2.05	3.64	32.02
1906	2.72	2.87	5.16	1.36	4.60	1.80	6.36	2.88	3.67	4.93	1.82	2.82	40.99
1907	3.29	2.47	1.79	3.73	3.54	2.18	1.48	1.52	8.50	3.23	5.73	4.58	42.04
1908	2.32	3.22	3.50	1.85	3.35	1.30	1.16	3.58	1.35	5.30	1.07	2.98	33.98
1909	4.62	4.34	2.89	5.37	2.68	2.99	1.51	2.52	4.43	1.41	3.44	1.77	37.97
1910	4.33	3.64	1.79	2.51	2.30	4.20	1.89	1.97	1.41	1.71	4.24	2.32	32.31
1911	2.58	2.65	2.94	2.50	1.85	2.93	4.51	5.49	2.90	2.59	6.41	3.14	40.49
1912	3.77	2.25	4.96	4.07	3.78	1.10	3.04	2.40	1.11	1.42	3.31	6.13	37.64
1913	3.01	3.15	4.86	5.49	2.29	1.54	3.02	2.61	3.27	7.01	2.12	3.17	41.84
Av.	3.24	3.02	3.79	3.53	3.00	2.84	3.30	2.87	3.92	3.52	3.59	3.40	40.02

RAINFALL AT BROCKTON, MASS. Elevation, 100 feet.
(Filter Beds.)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1894	2.67	3.00	1.38	3.29	3.82	1.25	2.56	0.98	2.93	6.52	4.12	5.12	37.64
1895	3.97	1.05	3.14	5.40	2.66	1.65	5.02	3.08	3.97	6.04	7.56	2.95	46.49
1896	2.14	3.80	4.68	0.97	2.21	3.49	1.53	2.03	7.25	2.77	3.92	2.00	36.79
1897	2.43	1.80	2.33	2.92	4.10	4.88	4.43	4.24	1.75	0.51	6.18	3.76	39.33
1898	3.08	4.65	1.97	5.36	3.89	1.46	6.52	6.73	1.79	8.00	5.65	2.07	51.17
1899	4.87	3.22	6.39	1.23	1.54	3.02	4.39	1.29	10.09	2.51	1.44	1.52	41.51
1900	3.95	6.16	4.49	1.59	4.96	5.04	2 70	2.22	4.37	3.19	4.64	2.60	45.91
1901	1.99	0.87	7.48	6.67	6.59	1.53	4.93	2.03	4.44	3.59	2.56	7.93	50.61
1902	1.81	2.85	5.97	2.55	0.82	3.29	2.12	1.78	2.65	3.39	1.38	4.50	33.11
1903	4.01	4.12	7.09	3.45	0.49	4.34	3.08	3.03	1.07	3.70	1.28	2.77	38.43
1904	3.47	3.20	2.26	6.98	3.12	2.46	1.95	3.07	5.02	2.05	1.61	2.28	37.47
1905	2.60	1.32	2.02	3.10	0.96	3.93	2.18	2 50	5.13	1.83	1.99	4.28	31.84
1906	2.71	2.33	4.55	1.78	4.74	1.59	5.36	3.08	4.31	4.84	1.95	3.25	40.49
1907	2.14	2.06	1.59	3.32	3.02	1.79	1.67	1.04	8.12	3.17	4.61	4.65	37.18
1908	2 27	3.47	2.96	1.52	3.19	0.99	3.80	3.06	1.28	4.39	0.47	2.93	30.33
1909	3.55	4.96	3.33	5.26	1.91	2.22	0.96	2.29	5.27	1.27	3.27	1.77	36.06
1910	4.30	3.70	2.38	2.87	2.52	5.20	2.19	1.97	1.35	2.47	4.76	2.56	36.27
Av.	3.06	3.09	3.77	3.43	2.97	2.83	3.26	2.61	4.16	3.54	3.38	3.35	39.45

RAINFALL AT BROCKTON, MASS. Elevation, 100 feet.
(Sewage Pumping Station.)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1894	2.73	2.94	1.31	2.92	3.57	0.41	1.91	1.12	3.36	6.97	3.94	4.79	35.97
1895	3.90	0.84	2.95	5.36	2.49	2.70	4.55	3.75	4.62	6.55	8.09	3.07	48.87
1896	1.84	4.47	5.68	1.04	2.28	3.60	1.45	2.28	8.09	3.75	4.47	2.06	41.01
1897	2.81	2.17	2.52	3.28	4.12	5.03	2.84	4.69	1.85	0.61	6.83	3.82	40.57
1898	3.18	6.01	2.09	5.01	3.77	1.91	6.91	6.62	2.30	7.92	5.75	2.38	53.85
1899	4.90	3.28	6.42	1.41	1.58	2.78	4.03	1.22	9.92	2.70	1.49	1.50	41.23
1900	4.11	6.43	4.58	1.59	5.61	4.62	3.02	1.18	4.80	3.44	4.90	2.38	46.66
1901	1.97	0.84	7.63	7.90	6.69	1.41	4.82	1.84	4.57	3.89	3.08	8.62	53.26
1902	2.06	5.03	7.13	3.02	0.78	4.42	2.60	3.18	3.40	4.27	1.51	4.94	42.34
1903	4.46	4.72	8.36	3.76	1.07	5.56	2.50	3.65	0.99	5.20	1.54	3.08	44.89
1904	2.88	2.87	2.73	8.77	3.25	2.73	2.88	2.93	5.99	2.33	2.03	2.97	42.36
Av.	3.17	3.60	4.67	4.01	3.20	3.20	3.41	2.95	4.53	4.33	3.97	3.60	44.64

RAINFALL AT CAMBRIDGE, MASS. Elevation, 75 feet.
(City Hall.)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1900	3.78	7.52	4.51	1.69	4.65	2.18	2.25	2.88	4.09	3.20	4.86	2.23	43.84
1901	1.63	0.88	6.49	7.72	6.77	1.28	4.70	3.87	3.55	2.65	2.88	7.29	49 71
1902	2.00	6.59	4.95	3.24	1.04	2.22	3.48	2.81	2.46	4.34	0.93	6.69	40.75
1903	3.91	4.09	5.32	3.57	0.20	6.33	2.97	3.09	2.43	3.12	1.26	3.14	39.43
1904	5.61	3.28	2.43	10.07	3.96	2.67	1.88	2.49	6.46	1.87	2.05	3.25	46.02
1905	5.43	1.59	3.21	3.05	1.88	4.80	0.93	3.59	7.27	1.86	2.36	3.38	39.35
1906	2.72	3.60	7.52	2.28	5.11	2.82	5.03	1.88	2.43	3.43	3.11	4.81	44.74

RAINFALL AT CAMBRIDGE, MASS. — *Continued.*
(City Hall.)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1907	2.91	2.86	2.66	3.46	3.38	3.64	1.71	1.77	8.70	3.16	6.70	4.83	45.78
1908	3.25	4.42	3.69	2.33	4.41	1.28	3.81	4.62	0.97	3.72	0.96	2.63	36.09
1909	4.35	5.40	3.65	4.27	2.04	4.21	1.33	3.67	5.33	1.28	4.01	3.22	42.76
1910	5.27	4.85	1.49	2.62	1.20	4.73	1.26	0.77	2.28	0.98	4.01	2.07	31.53
1911	2.70	2.85	3.15	2.28	0.31	3.81	4.12	4.60	3.45	2.54	4.49	3.65	37.95
1912	2.89	2.32	4.78	3.53	4.08	0.28	6.96	2.38	1.76	1.40	3.20	5.60	39.18
1913	2.73	3.56	5.21	5.17	3.40	0.95	2.77	3.18	2.88	6.71	2.35	3.22	42.13
Av.	3.51	3.85	4.22	3.95	3.03	2.94	3.09	2.97	3.86	2.88	3.08	4.00	41.38

RAINFALL AT CAMBRIDGE, MASS. Elevation, 40 feet.
(Fresh Pond.)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1883	...	...	...	...	...	...	...	...	...	...	...	...	30.82
1884	...	...	...	...	...	...	...	...	...	...	...	...	47.73
1885	...	...	...	...	...	...	...	...	...	...	...	...	46.20
1886	6.41	7.35	3.49	2.43	3.92	1.48	3.54	3.20	4.64	3.62	4.22	5.23	49.53
1887	5.28	4.66	4.46	3.94	1.79	1.86	4.19	4.10	1.36	3.22	3.90	4.22	42.98
1888	3.32	3.95	5.55	2.60	6.36	3.25	2.87	7.08	8.28	4.83	7.70	6.67	62.46
1889	6.64	2.81	3.29	3.73	5.65	3.44	8.53	3.78	5.30	3.73	6.51	3.36	56.77
1890	2.94	5.22	7.02	4.83	6.09	3.51	2.77	3.48	4.05	9.31	1.28	4.40	54.90
1891	6.68	4.61	5.74	2.72	2.44	4.01	3.06	3.68	2.73	5.10	3.08	6.78	50.63
1892	4.32	2.46	3.56	0.77	6.06	4.23	2.53	6.11	1.84	2.15	4.04	1.23	39.30
1893	1.87	6.43	2.50	3.25	7.30	2.18	2.26	5.95	1.76	3.77	1.99	5.23	44.49
1894	3.05	2.91	0.84	2.94	4.63	0.81	2.88	1.63	2.40	5.19	3.34	4.43	35.05
1895	3.57	1.07	2.68	4.15	2.39	2.76	3.28	4.71	1.83	10.16	6.09	1.90	44.59
1896	2.46	5.62	4.37	1.70	2.42	2.33	2.65	2.45	6.29	3.10	3.53	1.63	38.55
1897	3.32	2.36	2.66	2.82	4.24	5.16	4.68	5.06	3.22	0.55	6.83	4.31	45.21
1898	4.75	3.61	2.03	6.22	3.92	1.82	4.50	7.34	1.78	7.22	4.92	2.00	50.11
1899	3.85	3.99	5.94	1.32	0.77	3.17	3.12	3.21	4.63	3.08	2.20	1.30	36.58
1900	4.40	7.34	5.10	1.99	5.52	2.75	2.31	2.80	4.40	3.75	5.23	1.74	47.33
1901	1.55	0.79	6.89	8.80	6.96	1.33	4.70	4.17	3.74	2.86	2.67	7.71	52.17
1902	1.97	4.29	6.16	3.56	1.08	2.40	3.14	3.62	3.36	4.65	1.37	4.37	39.97
1903	3.19	3.50	4.89	3.98	0.35	8.46	3.72	3.81	1.72	4.54	1.70	2.87	42.73
1904	5.00	3.00	2.35	8.57	3.58	2.74	1.70	2.53	5.87	1.85	2.83	1.92	41.94
1905	3.47	1.09	2.52	2.87	1.30	4.41	1.86	3.06	5.97	1.30	2.91	3.63	34.39
1906	2.46	2.73	5.67	2.02	5.73	3.81	3.26	1.43	2.31	2.86	2.80	4.10	39.18
1907	2.46	1.59	1.91	2.64	2.86	2.66	1.20	0.69	7.92	2.57	5.95	3.87	36.32
1908	3.28	3.39	2.97	1.54	3.03	0.70	3.21	3.40	0.64	3.16	0.58	2.27	28.17
1909	3.92	4.81	3.41	3.41	1.53	3.45	1.45	3.03	5.11	0.88	3.15	3.11	37.26
1910	4.53	4.44	0.88	2.46	1.31	4.44	1.87	0.84	2.51	1.08	3.72	2.09	30.17
1911	2.64	2.82	3.08	2.27	0.44	3.66	4.86	4.01	3.12	1.14	3.32	3.43	34.79
1912	2.72	2.24	4.39	1.98	3.13	0.19	7.34	1.57	1.71	1.32	2.01	3.65	32.25
1913	2.16	2.28	3.24	4.31	3.50	0.97	2.63	3.09	2.26	6.84	2.40	2.86	36.54
Av.	3.65	3.62	3.84	3.35	3.51	2.93	3.36	3.57	3.60	3.71	3.58	3.58	42.30

RAINFALL AT CAMBRIDGE, MASS. Elevation, 40 feet.

(Prof. John Winthrop.)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1749	...	...	...	...	...	...	...	2.38	2.52	7.42	0.57	4.27	....
1750	2.36	0.71	3.93	4.03	3.65	3.08	4.24	9.46	2.14	2.72	2.08	3.83	42.23
1751	4.14	6.94	2.57	3.22	2.49	6.73	5.20	9.48	4.14	3.16	3.08	1.93	53.08
1752	2.08	2.14	5.73	2.27	1.26	5.34	4.93	1.33	0.87	7.12	1.88	3.07	38.02
1753	3.81	3.74	3.78	2.14	3.65	7.76	3.47	3.85	2.71	8.82	5.12	3.18	52.03
1754	4.34	3.22	3.22	1.30	3.91	7.16	7.14	2.69	0.35	3.48	5.72	3.95	46.48
1755	3.72	3.67	4.32	3.33	2.51	2.22	4.77	1.33	2.30	4.16	4.71	1.47	38.51
1756	3.64	0.81	2.19	3.62	2.51	4.95	2.75	2.64	1.31	5.01	4.34	1.69	35.46
1757	4.77	5.24	5.01	3.51	0.89	1.01	4.30	4.18	1.65	3.64	2.98	4.15	41.33
1758	7.19	3.04	2.13	1.54	3.08	5.64	9.83	7.58	1.21	4.14	4.17	4.18	53.73
1759	2.49	4.07	2.77	2.29	2.36	5.08	5.42	7.80	4.23	4.96	4.89	2.55	48.91
1760	2.50	1.67	1.54	1.24	4.01	4.25	0.85	5.10	6.33	2.82	2.79	5.89	38.99
1761	0.75	2.33	0.90	1.90	4.38	0.90	1.54	2.49	4.07	3.93	3.13	6.51	32.83
1762	4.13	0.94	1.50	1.47	2.13	0.89	1.76	2.74	0.89	6.01	0.66	1.35	24.47
1763	1.92	3.35	2.69	2.62	4.34	3.06	6.40	2.41	1.86	3.45	4.78	3.60	40.48
1764	0.05	3.37	1.41	4.49	1.90	1.75	6.05	2.17	4.39	3.10	3.57	4.58	36.83
1765	1.92	0.60	2.89	4.21	2.67	2.57	2.74	3.78	1.42	3.08	3.86	3.11	32.85
1766	1.75	0.94	4.03	3.74	3.19	2.40	5.85	4.37	2.77	5.32	1.64	1.73	37.73
1767	3.34	1.01	5.49	2.71	2.92	1.59	6.18	1.64	5.73	2.35	5.16	4.30	42.42
1768	2.79	2.07	1.48	1.23	2.54	3.32	4.27	3.81	5.66	3.04	2.18	4.36	36.75
1769	1.99	2.15	3.56	1.90	3.08	0.75	4.21	1.03	4.33	1.83	5.92	1.07	31.82
1770	4.25	3.15	1.06	1.64	4.03	3.52	1.39	8.85	3.71	5.31	3.17	1.19	41.27
1771	2.56	6.97	6.30	4.17	4.07	3.91	3.03	1.77	2.19	2.48	5.67	2.19	45.31
1772	1.75	4.38	2.06	4.92	2.28	1.81	3.96	6.86	7.65	6.63	3.56	3.12	48.98
1773	2.79	1.22	2.79	2.31	2.26	1.91	2.73	2.55	2.94	4.01	1.96	5.14	32.61
1774	2.46	1.89	2.63	2.81	3.88	3.28	2.16	3.92	3.17	2.46	6.29	2.47	37.42
1775	0.86	1.06	0.99	...	...	...	...	...	*2.67	*4.98	...	...	....
1776	...	...	...	...	...	...	...	...	...	...	†2.11	†3.22	....
1777‡	1.52	1.39	2.03	2.52	3.74	3.86	3.42	3.75	3.77	4.54	3.43	1.50	35.47
1778†	3.12	3.05	2.91	1.85	2.97	4.78	1.53	6.01	2.38	2.15	3.98	2.38	37.11
1779	2.33	3.29	2.37	2.53	...	...	...	...	...	...	...	...	....
Av.	2.92	2.79	3.04	2.74	2.96	3.40	4.21	4.15	3.12	4.12	3.73	3.24	40.42

* At Watertown. † At Concord. ‡ Not in average.

RAINFALL AT CAMBRIDGE, MASS. Elevation, 75 feet.

(Harvard College Observatory.)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1841	4.90	1.81	3.14	4.71	1.98	0.66	3.02	6.15	3.27	3.72	2.76	5.14	41.26
1842	0.78	3.18	2.76	3.36	2.53	5.84	1.42	5.60	3.34	1.26	4.14	6.64	40.85
1843	2.26	6.56	5.83	4.13	2.17	5.38	2.47	8.75	1.52	5.81	4.26	3.34	52.48
1844	4.48	2.03	5.84	0.34	3.08	1.77	2.90	3.35	4.50	3.27	4.50	1.22	37.28
1845	3.93	3.78	3.67	1.48	2.63	3.15	4.07	2.53	2.58	4.22	10.43	6.71	49.18
1846	2.60	1.50	1.56	1.50	3.59	2.68	3.19	2.38	2.01	1.63	2.55	5.19	30.38
1847	3.67	3.34	3.88	2.83	1.94	5.49	2.53	5.40	6.54	1.44	4.94	4.37	46.37
1848	2.89	4.00	2.50	1.21	7.71	2.81	2.58	3.50	5.18	6.31	1.16	3.23	43.11
1849	0.72	1.46	6.90	1.18	2.76	1.37	0.97	6.52	2.13	7.56	5.43	3.78	40.78
1850	3.86	2.51	3.28	4.79	7.22	2.97	2.62	7.64	9.82	2.51	3.59	3.34	54.15
1851	1.06	4.22	2.01	9.10	4.14	1.62	3.21	1.21	3.98	4.67	4.96	2.00	42.18
1852	2.22	0.62	2.10	7.94	2.30	4.03	1.86	7.50	2.01	2.92	3.83	3.17	40.50
1853	3.88	5.70	3.31	3.70	6.45	0.55	3.02	8.59	5.95	3.49	4.91	4.29	53.84
1854	1.86	3.97	2.95	4.84	5.45	3.58	3.24	0.35	4.36	2.11	7.98	4.47	45.16
1855	7.26	3.74	1.16	3.99	1.51	3.58	4.84	2.27	1.22	5.51	5.33	7.19	47.60
1856	5.30	0.57	0.97	3.44	6.73	2.87	4.24	14.98	4.66	3.24	2.89	3.90	53.79
1857	7.87	3.72	3.50	8.95	5.17	1.71	6.33	6.67	2.94	3.69	2.56	4.83	57.94
1858	3.44	1.86	1.77	3.81	3.71	7.55	4.36	5.57	5.11	2.87	2.38	3.04	45.47
1859	8.23	6.48	8.44	2.36	2.98	6.81	1.50	5.39	5.37	3.12	3.68	4.99	59.35
1860	1.00	2.21	1.73	1.32	2.26	7.41	5.19	5.24	9.33	1.86	4.12	4.75	46.42
1861	8.93	2.79	6.56	6.02	3.19	2.56	3.59	5.57	1.77	2.68	3.31	3.31	50.28
1862	7.70	2.79	6.21	1.73	2.32	6.29	5.05	6.29	4.66	5.24	6.73	2.20	57.21
1863	4.43	1.63	2.46	7.39	1.67	2.47	12.43	5.57	2.98	3.40	6.53	5.46	56.42
1864	3.34	0.89	5.59	7.81	2.91	0.78	1.20	2.55	1.68	4.60	3.52	4.59	39.46
1865	4.87	4.31	4.25	2.88	6.24	2.20	3.67	1.76	1.00	5.71	3.68	3.02	43.59
1866	1.20	4.78	3.60	1.60	3.91	2.74	3.32	1.73	5.71	0.96	2.38	0.58	32.51
1867	4.36	4.10	4.22	2.08	2.96	1.75	5.45	7.95	0.50	5.02	1.84	1.48	41.71
1868	2.53	0.95	1.85	4.73	7.32	2.50	0.78	4.93	7.07	1.18	4.31	1.74	39.89
1869	3.43	5.80	5.33	2.03	4.94	3.64	2.65	1.55	5.92	5.18	2.43	5.08	47.98
1870	5.69	4.22	4.66	6.13	1.97	3.83	1.20	2.03	1.81	3.76	3.52	2.71	41.53
1871	1.45	2.63	3.70	3.03	3.60	5.35	2.96	3.10	1.08	5.70	4.78	3.18	40.56
1872	1.93	2.30	3.09	2.68	3.51	4.64	5.17	10.97	6.67	3.66	4.18	3.93	52.73
1873	5.97	4.04	3.36	3.08	4.09	0.50	3.67	5.07	3.22	4.28	4.89	4.64	46.81
1874	3.28	4.42	1.49	6.39	3.50	3.87	2.54	6.82	1.52	1.07	2.33	1.50	38.73
1875	3.22	3.51	8.10	4.73	3.08	6.60	2.88	5.66	3.46	3.83	4.86	1.04	51.00
1876	1.82	4.74	6.53	4.65	3.07	1.92	6.08	1.38	3.77	1.82	6.78	5.09	47.65
1877	3.87	0.89	7.46	3.66	3.58	2.26	2.66	4.58	0.51	6.77	7.60	0.84	44.68
1878	5.84	6.59	4.17	5.15	0.87	2.68	4.82	6.21	2.24	5.06	6.52	4.39	54.54
1879	2.20	3.43	4.02	5.65	1.28	4.59	2.61	5.79	1.71	0.76	3.18	2.75	38.00
1880	3.79	4.20	3.28	2.00	1.51	0.80	6.75	3.49	1.71	2.78	2.10	2.81	35.22
1881	7.43	4.21	7.48	1.74	3.31	5.71	3.68	1.35	2.89	1.98	4.61	3.11	47.53
1882	4.15	6.40	2.75	2.26	4.95	1.97	2.35	1.61	8.28	2.01	1.68	2.16	40.57
1883	2.86	3.84	2.05	2.40	3.63	2.73	2.63	0.43	0.98	5.57	1.95	3.58	32.65
1884	5.20	6.39	4.89	4.36	3.08	3.83	4.06	4.68	0.66	2.54	2.85	4.88	47.42
1885	4.85	3.26	1.32	3.56	3.66	4.13	1.50	5.02	1.80	5.68	6.12	1.91	42.81
1886	7.36	7.82	3.53	2.07	3.21	1.44	3.23	2.81	3.45	2.72	3.91	5.05	46.60
1887	7.09	4.96	5.66	5.46	1.69	1.90	4.16	3.73	1.12	3.36	2.87	3.71	45.71
1888	3.55	3.27	5.26	2.56	4.63	2.51	2.54	7.15	7.84	4.68	7.46	4.78	56.23
1889	6.03	1.44	1.05	2.54	5.33	2.53	6.42	3.27	4.30	3.65	4.97	2.22	43.75
1890	1.97	2.85	6.53	2.03	5.06	2.80	1.42	2.85	3.70	8.09	1.15	5.15	43.60

RAINFALL AT CAMBRIDGE, MASS. — *Continued.*

(Harvard College Observatory.)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1891	6.09	4.56	4.90	2.44	2.10	3.57	2.93	3.21	2.63	4.82	2.22	3.29	42.76
1892	4.30	1.70	2.90	0.80	5.35	3.72	1.24	6.65	2.18	1.76	4.68	1.23	36.51
1893	2.03	7.28	3.71	2.66	5.06	1.62	2.05	5 20	1.35	3.46	1.79	4.79	41.00
1894	3.33	3.59	0.37	2.67	2.27	0.38	2.56	1.83	2.42	5.23	3.49	4.32	32.46
1895	3.85	1.23	2.66	3.58	1.98	2.73	3.35	3.90	2.14	7.10	8.84	2.19	43.55
1896	3.06	4.35	6.27	1.66	2.04	2.15	2.87	2.13	6.18	3.11	3.34	1.57	38.73
1897	4.01	2.53	2.92	2.70	3.78	5.98	4.06	4.47	3.00	0.40	6.45	1.31	41.61
1898	4.07	5.35	2.03	5.26	3.73	1.66	4.25	7.29	1.72	6.71	6.63	2.53	51.23
1899	4.96	5.41	6.67	1.37	1.46	2.90	2.49	2.59	4.31	1.55	3.56	1.51	38.78
1900	4.71	8.18	4.86	1.90	4.93	2.47	2.24	2.76	4.54	3.71	5.24	2.53	48.07
1901	1.73	1.16	6.74	8.26	7.41	1.09	4.06	3.95	3.78	2.87	2.80	8.24	52.09
1902	2.36	4.76	6.40	3.57	1.26	2.08	3.09	2.86	3.00	4.47	1.19	5.99	41.03
1903	3.54	3.65	6.09	4.07	0.38	7.40	3.11	3.56	1.67	4.05	1.52	3.25	42.29
1904	5.15	2.76	2.85	9.28	3.77	2.64	1.68	2.37	5.84	2.00	1.80	2.64	42.78
1905	6.13	1.90	2.86	2.63	1.53	4.30	1.07	3.04	5.99	1.23	2.24	3.65	36.57
1906	2.82	3.05	7.32	2.32	4.67	1.68	5.37	1.66	2.44	3.09	3.47	2.80	40.69
1907	4.82	1.77	1.76	3.55	3.15	3.15	1.29	1.12	8.54	2.88	6.94	2.79	41.76
1908	3.55	4.23	2.81	1.31	4.00	1.25	3.34	4.01	0.83	3.20	0.81	2.70	32.04
1909	4.62	5.22	2.90	3.90	2.01	3.82	1.62	3.19	5.54	1.12	1.99	4.47	40.40
1910	4.59	3.02	1.38	2.54	1.07	4.98	1.73	0.78	2.55	0.97	3.56	2.96	30.13
1911	1.82	1.44	3.10	3.17	0.26	3.68	4.82	3.52	3.86	2.58	4.49	3.11	35.85
1912	2.92	2.49	5.69	2.80	3.29	0.88	6.64	1.74	1.08	1.41	2.74	4.87	36.55
1913	2.60	2.76	5.09	4.10	3.34	1.03	2.59	1.45	3.26	6.73	2.16	4.42	39.53
Av.	3.97	3.55	3.97	3.62	3.41	3.13	3.34	4.23	3.54	3.55	3.99	3.56	43.86

RAINFALL AT CHESTNUT HILL RESERVOIR. Elevation, 124 feet.

(Metropolitan Water Works.)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1873	5.67	2.68	2.25	2.97	4.41	0.26	3.58	6.76	2.33	5.45	6 23	4.77	47.36
1874	2.14	1.50	1.62	7.42	3.99	3 21	2.72	7.07	1.71	1.03	2.24	1.86	36.51
1875	3.52	3.46	4.54	3.69	3.92	7.10	3.17	6.35	3.37	4.11	5.22	0.72	49.17
1876	1.73	4.60	7.27	4.02	2.80	1.78	6.84	1.76	4.22	1.83	8.29	3.31	48.45
1877	3.39	0.83	8.78	3.37	3.39	2.41	2.23	5.56	0.49	8.06	8.28	0.99	47.78
1878	5.97	6.96	4.93	5.95	0.79	2.26	3.34	5.03	2 53	5.29	7.29	4.76	55.10
1879	2.10	3.02	3.56	6.02	0.85	4.77	3.03	7.15	1.88	0.77	2.71	3.93	39.79
1880	2.95	3.12	2.82	2.41	1.71	0.72	6.14	2.52	1.75	3.08	2.23	2.05	31.50
1881	5.13	4.46	5.77	1.71	2.74	6.13	2.99	0.77	3.25	2.78	3.50	3.42	42.65
1882	4.12	4.15	2.80	2.40	5.34	1.41	2.89	1.28	9.18	1.87	1.17	1.88	38.49
1883	3.12	3.32	1.70	2.26	4.25	2.56	2.41	0.28	1.31	5.33	2.01	3.24	31.79
1884	4.84	6.38	4.23	4.46	2.89	4.73	5.47	4.78	0.42	3.41	3.02	4.92	49.55
1885	5.33	3.22	1.25	3 46	4.02	4.14	1 60	6.03	1 75	5.87	6.42	2.34	45.43
1886	7.17	7.89	3.55	2.71	3.41	1.38	2.59	3.52	3.03	3.21	4.03	5.82	48.31
1887	5.57	4.44	5.20	4.74	1.69	2.08	3.69	3.53	1.35	3.21	2.75	3.66	41.91
1888	3.88	3.34	5.53	2.44	5.90	2.58	2.16	6.92	9.42	4.54	8.17	5 36	60.24
1889	6.50	1.93	2.37	3.82	4.78	3.31	9.53	4.51	5.30	3 85	6.23	2.66	54.79
1890	2.52	3.12	7.64	2.93	5.80	2.60	2.43	3.37	4.89	8.79	1.37	4.76	50.22
1891	6.93	5.34	5.63	2.98	2.05	4.04	3 44	4.04	3 05	5 70	2.70	3.73	49 63
1892	4.45	2.78	3.95	0.75	6.08	3 89	3 35	5.92	2.16	2 39	5.26	1.29	42.27

RAINFALL AT CHESTNUT HILL RESERVOIR. — *Continued.*

(Metropolitan Water Works.)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1893	2.74	8.31	3.15	3.32	5.77	2.33	2.10	6.53	1.85	3.70	2.00	4.91	46.71
1894	3.90	3.81	1.14	3.24	4.27	0.20	3.33	2.27	2.50	6.04	3.41	4.06	38.17
1895	3.91	0.88	2.91	4.60	2.58	2.21	3.55	3.91	2.15	9.21	7.69	2.33	45.93
1896	2.80	5.45	5.53	1.72	1.85	2.98	3.00	2.74	7.16	3.49	3.61	1.89	42.22
1897	4.09	2.79	3.08	3.23	4.40	4 53	4.38	4.68	3.22	0.53	6.74	4.50	46.17
1898	5.60	5.58	2.20	6.17	4.45	2.36	5.57	6.06	1.77	7.38	7.42	2.93	57.49
1899	4.51	5.01	7.05	1.47	0.91	2.73	3.70	3.81	5.38	3.05	2.59	1.75	41.96
1900	4.38	8.74	5.03	2.24	5.41	2.90	2.68	2.15	4.12	3.79	5.30	2.85	49.59
1901	1.72	0.77	7.25	8.21	7.14	1.23	6.40	4.15	3 25	3.01	2.83	8.25	54.21
1902	1.98	7.76	5.27	3.97	1.11	2.74	3.52	2.96	3.31	4.64	1.56	5.43	44.25
1903	3.95	4.60	6.62	4.33	0.79	8.14	3.54	4.01	2.96	4.87	1.53	3.01	48.35
1904	5.64	2.96	2.79	9.18	3.28	2.75	1.48	2.74	5.75	2.21	1.81	2.81	43.40
1905	5.49	2.27	3 34	3.08	1.65	5.38	1.92	3.47	5.93	1.53	2.51	4.27	40.84
1906	3.65	3.17	7.42	2.62	5.43	3.56	4.13	1.82	2.92	3.71	3.37	5.36	47.16
1907	3.80	3.31	2.44	3.72	4 06	3.39	1.49	1.79	10 02	3.65	7.91	6 25	51.83
1908	4.50	6.22	4.18	2.64	4.56	1.28	4.18	5.56	1.22	4.34	1.17	3.46	43.31
1909	4.79	6.61	4.27	3.98	2.44	4 12	1.10	4.11	5.79	1.58	4.89	4.39	48.07
1910	6.11	5.69	1.16	3.57	2 03	5.36	1.93	1.18	2.65	1.69	4.77	2.91	39.05
1911	3.05	3.43	3.27	2.55	0.58	3.84	4.69	5.01	3.59	3.22	4.40	3.65	41.28
1912	3.64	2.48	5.36	3.92	4.06	0.34	6.39	2.24	1.72	1.61	3.00	5.20	39.96
1913	3.38	2.71	5.42	4.90	3.46	1.04	2.25	4.56	3.07	6.48	2 69	3.33	43.29
Av.	4.16	4.12	4.25	3.74	3.44	3.04	3.54	3.97	3.51	3.91	4.15	3.64	45.47

RAINFALL AT CLINTON, MASS. Elevation, 300 feet.

(Bigelow Carpet Co.)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1877	...	...	...	2.50	1 03	2.28	3.35	3.40	0.31	5.84	8.68	1.07	42.98
1878	...	...	...	...	...	...	...	...	...	....	....	...	56.83
1879	...	...	...	...	...	...	...	...	...	...	...	...	43.57
1880	4.54	2.68	3.05	2 80	1.61	2.13	7.68	3.37	2.20	3.81	2.01	1.73	37.61
1881	5.08	3.16	8.55	2.45	3.93	5.64	2.50	1.42	3.21	1.31	5 55	4.80	47.60
1882	4.27	5.86	2.97	1.80	5.53	2.86	1.56	1.31	8.95	2.31	0 76	2 75	40.96
1883	2.80	3.91	1.83	1.85	4 63	3.85	2.10	0.49	2.10	5.66	1.70	3.19	34.11
1884	6.03	6.08	6.43	4.83	3.14	4.94	3.62	4.47	1.13	2.12	2.03	5.50	50.32
1885	4.31	3 88	0.92	3.30	3.31	3.24	2.51	6.11	1.39	5.01	5.89	3.71	43.58
1886	4.92	5.66	3.69	2.70	3.15	1.61	3.39	3 54	3 78	2.80	5.18	3 72	44.14
1887	4.34	5.05	5.07	4.07	1.68	2.70	6.07	10 26	1.08	2.64	3.48	4.19	50.63
1888	4.24	4.09	4.18	2.98	4.41	2.85	2.66	4 91	8.37	6.49	6.36	5.84	57.38
1889	5.37	1.54	1.28	4.46	2.80	1.55	8.17	3.66	3.95	4.51	6.85	2.43	46.57
1890	2.91	3.52	6.61	2.15	5.16	3.23	3.63	5.36	5.33	9.49	1.84	3 93	53.46
1891	7.46	5.05	5.26	3.62	2.20	3.76	2.89	3.72	1.98	3.37	2 15	4.27	45 73
1892	5.21	2.39	2.60	0.55	6.11	1 36	3.93	5.55	1.64	0.31	5.39	0.94	35.98
1893	2.05	5.61	3.79	2.88	6.38	2.34	1.53	4.91	1.45	4.24	2.11	4.75	42.07
1894	2.24	1.77	1.33	3.02	3.07	0.98	2.75	0.76	1 97	4.12	3.17	2.25	27.43
1895	3.73	0.22	2.47	4.93	1.80	4.60	3.52	3.15	1 63	8.88	5.87	3 60	44.40
1896	1.91	5.95	4 12	1.64	2.34	1.60	4.11	2.65	6.21	2.91	2.70	1.79	38.53
1897	3.07	1.51	3.73	1 85	3.87	4 04	7.17	2.75	1 91	1.20	5 62	4 12	40.84
1898	6 23	2.28	1.39	3.06	2.53	2.49	2.34	7.52	2.21	5.97	5 61	2.70	44 33

RAINFALL AT CLINTON. — *Continued.*

(Bigelow Carpet Co.)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1899	2.81	3.91	6.53	1.50	0.92	5.12	3.30	3.37	3.65	1.52	2.13	1.52	36.28
1900	3.43	7.47	5.29	1.90	2.71	2.20	3.08	2.91	2.52	2.20	4.18	1.78	39.67
1901	1.63	0.72	4.31	4.61	4.96	0.42	5.48	3.20	2.61	3.40	1.41	9.69	42.44
1902	2.02	4.35	4.70	2.51	1.88	1.74	2.85	2.88	4.45	6.91	0.64	7.10	42.03
1903	2.61	4.35	4.89	2.29	0.76	8.98	3.23	3.12	2.10	3.14	1.90	3.51	40.88
1904	3.83	2.10	2.57	4.47	2.41	3.20	4.65	5.90	4.52	1.11	1.10	2.50	38.36
1905	5.09	1.60	3.80	2.08	0.90	4.44	3.34	2.54	5.91	1.51	2.25	2.54	36.00
1906	1.60	2.24	3.70	2.49	4.20	4.18	5.04	5.69	2.42	3.14	2.21	4.96	41.87
1907	2.14	2.62	2.05	2.78	2.51	2.90	2.13	1.88	9.74	5.38	4.03	4.33	42.79
1908	2.12	5.14	2.76	1.84	3.72	1.02	3.59	6.81	1.14	1.56	0.91	2.47	33.08
1909	3.73	5.76	3.65	4.38	2.80	2.18	3.46	2.28	3.83	0.75	4.50	3.04	40.36
1910	6.38	4.83	2.39	2.87	1.30	4.37	1.50	4.53	3.75	2.71	3.77	3.41	41.81
1911	3.00	2.96	3.91	1.48	1.56	1.87	1.59	5.11	3.17	3.58	3.74	2.63	34.60
1912	3.25	2.50	6.12	3.17	7.18	0.26	3.31	3.61	2.15	2.58	3.95	5.21	43.29
1913	2.92	2.71	4.76	4.13	3.56	1.14	1.72	1.90	4.29	6.30	2.83	3.14	39.40
Av.	3.74	3.63	3.85	2.87	3.22	2.93	3.56	3.87	3.43	3.62	3.35	3.65	41.72

RAINFALL AT CLINTON, MASS. Elevation, 370 feet.

(Metropolitan Water Works.)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1902	1.70	5.70	5.76	4.21	2.09	2.13	2.96	3.23	5.68	6.22	0.93	6.81	47.42
1903	3.31	4.59	6.07	3.21	0.82	12.19	3.45	3.50	2.02	4.23	2.25	4.20	49.84
1904	4.37	2.30	3.30	8.63	3.10	3.36	3.68	5.21	5.19	1.44	1.45	2.57	44.60
1905	5.96	1.78	4.29	2.64	1.01	4.92	4.15	3.16	7.07	1.70	2.33	4.26	43.27
1906	2.51	3.30	5.15	3.18	6.55	6.46	5.80	5.76	2.42	3.01	3.21	4.41	51.76
1907	2.65	1.91	2.14	3.85	3.37	4.67	2.83	1.47	9.99	5.55	6.46	4.54	49.43
1908	3.63	3.99	2.97	2.46	5.17	1.17	3.94	6.86	1.19	2.30	1.33	3.49	38.50
1909	4.11	7.22	4.97	5.39	3.29	3.13	4.03	3.09	4.86	1.52	2.41	4.54	48.56
1910	6.49	4.57	1.28	2.93	1.77	4.68	1.53	4.07	2.98	1.88	4.52	2.40	39.10
1911	3.09	2.81	4.28	2.36	1.41	3.11	2.53	5.31	2.98	4.87	2.59	3.39	38.73
1912	3.31	2.56	6.30	4.36	7.32	0.27	3.51	3.63	2.33	2.78	4.26	5.03	45.66
1913	3.20	2.76	5.03	4.11	4.00	1.03	1.96	2.03	4.21	6.48	2.73	3.50	41.07
Av.	3.69	3.62	4.30	3.94	3.33	3.93	3.36	3.94	4.25	3.50	2.87	4.10	44.83

RAINFALL AT CLINTON, MASS. Elevation, 300 feet.

(Clinton Wire Cloth Co.)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1880	3.89	2.40	3.86	2.60	1.84	2.38	8.12	3.40	2.18	3.73	1.93	2.21	38.54
1881	3.45	4.91	5.69	2.05	3.86	4.95	2.70	0.77	3.65	2.53	3.60	4.69	42.85
1882	3.15	3.27	2.04	1.67	4.95	2.75	1.52	1.30	8.45	2.30	0.80	1.40	33.60
1883	2.29	4.05	1.76	1.57	4.82	4.48	1.94	0.49	2.28	5.07	1.73	2.30	32.78
1884	6.57	5.99	6.90	5.78	2.46	5.50	3.62	4.96	0.73	2.12	2.16	6.66	53.45
1885	6.76	3.76	0.91	4.25	3.22	3.61	2.72	6.40	1.24	5.17	7.23	4.01	49.28
Av.	4.35	4.06	3.53	2.99	3.52	3.94	3.44	2.89	3.09	3.49	2.91	3.54	41.75

RAINFALL AT CLINTON, MASS. Elevation, 370 feet.
(Lancaster Mills.)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1878	4.70	4.19	4.27	5.77	0.43	3.69	4.03	7.18	1.45	5.25	6.15	6.09	53.20
1879	1.41	2.36	3.93	4.62	1.62	5.11	4.03	5.55	1.27	0.87	2.60	3.56	36.93
1880	3.43	2.62	1.98	2.12	1.68	1.85	6.90	3.00	2.70	3.40	1.77	2.06	33.51
1881	4.01	3.87	5.64	2.00	3.32	5.00	3.12	1.30	2.55	2.41	3.27	4.69	41.18
1882	4.35	4.03	1.83	1.65	5.65	3.64	1.88	1.62	9.94	2.45	0.98	2.27	40.29
1883	2.47	3.40	1.50	1.42	4.05	3.45	2.52	0.45	1.95	5.09	1.55	2.41	30.26
1884	5.10	6.43	6.31	4.83	2.75	4.95	3.30	3.25	0.75	1.57	2.08	5.05	46.37
1885	4.28	3.50	0.90	2.95	2.55	2.60	2.00	5.25	1.39	3.85	5.90	2.95	38.12
1886	3.70	5.10	3.15	2.10	2.43	1.58	3.40	2.60	3.15	3.45	4.35	3.00	38.01
1887	4.72	4.45	4.40	3.00	1.50	2.55	5.55	9.80	6.25	2.30	2.78	3.97	51.27
1888	3.85	3.52	4.18	2.47	3.25	2.12	2.33	4.89	7.35	6.08	5.85	5.60	51.49
1889	5.03	1.12	1.08	3.76	2.43	0.89	7.29	2.91	5.35	3.55	5.87	2.13	41.41
1890	2.00	2.65	6.08	2.00	5.01	2.70	3.15	4.80	4.75	9.05	1.05	4.28	47.52
1891	6.10	4.28	5.20	2.90	2.08	3.25	3.10	2.80	2.10	2.85	1.72	3.62	40.00
1892	4.80	1.83	2.53	0.43	5.57	1.20	3.40	3.65	1.35	0.39	4.65	0.75	30.55
1893	1.85	4.90	3.15	2.60	5.90	1.95	0.90	3.70	1.15	3.95	1.75	4.35	36.15
1894	2.55	1.95	1.08	2.40	3.41	0.70	2.70	0.67	1.35	3.60	2.50	2.75	25.66
1895	3.15	0.60	1.80	3.83	1.07	4.05	1.90	3.15	1.10	9.55	5.45	2.50	38.15
1896	1.88	6.25	6.25	0.80	1.55	1.92	3.25	2.00	6.64	2.83	1.87	1.15	36.39
1897	1.95	1.90	3.08	1.40	3.02	3.98	6.70	3.30	1.47	0.75	6.08	5.57	39.20
1898	3.40	4.50	0.90	3.80	2.50	1.70	2.75	8.48	1.62	5.55	4.63	3.22	43.05
1899	2.45	1.68	5.77	1.50	0.50	4.43	2.25	3.70	3.62	1.85	1.44	0.87	30.06
1900	3.75	7.55	6.65	1.65	2.97	2.45	2.12	2.95	2.13	2.50	5.90	2.25	42.87
1901	0.95	0.60	5.05	8.45	5.70	0.35	6.32	4.40	1.70	3.65	2.35	8.00	47.52
1902	1.30	3.65	3.60	3.80	1.25	1.13	2.50	2.92	4.50	5.90	0.40	5.15	36.10
1903	2.58	2.82	5.25	2.55	0.10	10.93	3.20	3.50	1.95	4.38	2.20	4.01	43.47
Av.	3.30	3.45	3.68	2.88	2.78	3.01	3.48	3.76	3.06	3.73	3.27	3.55	39.95

RAINFALL AT COHASSET, MASS. Elevation, 50 feet.

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1895	...	...	...	...	...	...	...	3.90	2.02	8.47	6.18	2.76	....
1896	3.05	4.60	5.66	1.48	2.77	4.44	2.59	2.23	6.19	3.80	6.05	2.35	45.21
1897	3.85	2.78	3.16	**3.26**	4.70	3.71	4.85	5.09	2.34	0.99	7.65	4.29	46.67
1898	3.26	9.17	3.48	8.47	4.62	1.54	6.98	8.95	2.12	8.56	6.62	1.14	64.91
1899	5.22	4.61	7.18	1.38	1.16	2.53	3.67	1.22	7.88	2.27	3.53	1.41	42.06
1900	4.43	6.17	4.31	2.01	5.39	3.20	3.01	1.71	4.92	4.71	5.68	2.90	48.44
1901	2.43	0.87	6.69	8.76	7.95	2.01	9.69	3.04	3.77	4.24	2.88	8.49	60.82
1902	1.74	5.76	6.17	3.26	1.11	4.50	2.36	1.76	3.14	4.49	1.68	6.65	42.62
1903	**3.69**	**4.54**	7.34	5.40	0.76	6.75	4.22	3.66	1.15	3.91	2.05	2.25	45.72
Av.	3.46	4.81	5.50	4.25	3.56	3.58	4.67	3.46	3.94	4.12	4.52	3.69	49.56

RAINFALL AT CONCORD, MASS. Elevation, 139 feet.

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1891	5.45	4.78	5.70	2.63	1.63	3.43	2.97	2.85	1.69	3.16	2.65	3.03	39.97
1892	5.16	2.27	3.00	0.71	5.12	4.08	3.47	4.20	2.43	1.71	5.54	0.99	38.68
1893	3.11	5.48	3.03	2.91	5.16	2.95	1.93	6.15	1.86	4.35	2.00	4.36	43.29
1894	2.47	2.69	0.93	2.10	4.22	0.53	3.22	1.81	2.21	4.20	3.28	3.11	30.77
1895	3.25	0.85	2.35	1.41	1.56	2.13	3.70	3.45	2.73	6.80	8.69	2.31	42.26

RAINFALL AT CONCORD, MASS. — *Continued.*

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1896	1.83	5.04	5.19	1.59	2.26	2.25	3.41	3.10	6.69	3.17	2.59	1.70	38.82
1897	3.18	2.52	3.75	2.26	4.39	3.88	4.50	3.45	2.99	0.35	5.81	4.34	41.42
1898	4.50	4.57	1.87	4.48	2.81	2.36	5.80	8.94	2.34	6.43	5.02	2.77	51.89
1899	3.02	3.47	3.98	1.50	0.97	4.11	3.36	3.07	4.01	1.63	2.49	1.72	33.33
1900	3.56	6.11	4.40	1.92	3.81	2.49	2.18	1.91	3.49	3.15	5.09	2.32	40.43
1901	1.46	1.17	3.89	6.72	7.52	1.81	5.15	3.26	2.71	2.91	2.10	7.47	46.17
1902	1.66	3.12	5.02	3.35	2.39	1.89	2.78	4.26	5.78	4.76	0.85	5.32	41.18
1903	3.16	3.05	6.05	2.82	0.76	8.30	3.27	3.26	2.10	4.41	1.61	2.72	41.51
1904	3.69	2.16	2.25	9.40	3.72	5.13	2.21	3.13	5.19	1.55	1.52	2.13	42.08
1905	4.66	1.85	3.22	2.78	0.93	5.27	2.00	3.20	7.59	1.37	1.98	4.24	39.09
1906	2.42	2.46	5.66	2.79	5.07	3.12	5.37	3.86	2.15	2.55	2.67	3.89	42.01
1907	3.03	1.40	1.99	2.84	3.31	2.81	2.52	1.17	9.05	4.73	5.42	4.23	42.50
1908	2.82	4.31	2.78	1.34	5.07	1.02	3.42	5.22	0.75	2.57	0.95	2.75	33.00
1909	4.09	5.21	3.22	4.85	2.35	3.30	3.76	2.48	4.89	1.11	3.06	3.13	41.45
1910	4.30	4.16	1.44	2.50	1.47	3.35	1.63	2.22	2.97	1.65	3.52	2.03	31.24
1911	2.57	2.54	3.29	2.26	0.29	3.23	3.33	4.60	3.16	3.42	4.09	3.33	36.11
1912	2.85	2.55	5.63	3.99	4.93	0.26	3.49	3.37	2.51	2.55	3.73	4.85	40.71
1913	2.57	2.78	4.98	3.94	3.87	1.63	1.77	3.65	3.23	5.60	2.11	2.82	38.95
Av.	3.25	3.24	3.64	3.22	3.20	3.01	3.27	3.59	3.59	3.22	3.34	3.29	39.86

RAINFALL AT COTUIT (BARNSTABLE), MASS. Elevation, 60 feet.

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1885	5.38	2.87	1.49	2.98	3.76	4.39	0.68	5.03	3.35	2.67	3.56	2.81	38.97
1886	3.71	4.72	5.51	1.51	3.43	1.29	2.61	3.99	1.97	4.93	3.88	5.11	42.66
1887	4.39	5.59	4.49	4.98	2.18	2.39	2.99	4.50	1.82	2.10	2.92	4.58	42.93
1888	3.57	1.80	4.48	2.05	6.48	2.01	4.42	1.78	9.80	4.34	6.14	4.22	51.09
1889	4.22	3.71	3.56	4.44	4.19	2.65	4.09	5.20	3.03	5.58	5.44	2.34	48.45
1890	2.28	2.65	7.06	2.80	3.53	3.68	1.60	4.98	6.44	10.14	1.45	3.85	50.46
1891	7.50	5.75	3.66	2.65	2.62	1.65	2.19	4.13	5.57	10.14	1.72	3.77	51.35
1892	3.94	1.94	4.78	2.38	4.86	1.95	1.18	3.56	2.22	**1.96**	**7.55**	**2.13**	38.45
Av.	4.37	3.63	4.38	2.97	3.88	2.50	2.47	4.15	4.28	5.23	4.08	3.60	45.54

RAINFALL AT DALTON, MASS. Elevation, 1 200 feet.

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1906	2.08	2.04	4.97	3.55	4.36	2.36	5.38	3.94	3.62	3.26	2.26	2.45	40.27
1907	3.25	1.72	1.13	2.07	3.86	3.67	2.36	1.91	8.07	7.52	4.21	3.69	43.46
1908	3.07	3.16	2.94	2.35	5.10	2.37	5.51	4.19	0.97	1.52	0.71	2.78	34.67
1909	4.00	5.25	4.04	3.92	2.02	3.00	1.70	3.49	3.63	1.16	1.83	1.95	35.99
1910	5.24	4.07	0.91	3.68	4.16	2.78	2.82	2.91	4.75	1.16	3.73	2.08	38.29
1911	3.08	1.72	3.84	2.20	2.39	2.00	2.92	5.38	3.67	6.22	2.55	3.17	39.14
1912	2.04	1.79	4.52	5.22	5.73	1.51	2.81	5.32	3.40	3.65	4.42	4.36	44.77
1913	4.73	2.77	6.70	3.36	3.30	1.28	2.71	2.65	2.87	5.33	4.21	2.62	42.53
Av.	3.44	2.82	3.63	3.29	3.86	2.37	3.28	3.72	3.87	3.73	2.99	2.89	39.89

RAINFALL AT DUDLEY, MASS. Elevation, 450 feet.

(Stevens Linen Works.)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1892	2.89	2.00	3.59	0.72	5.89	3.38	2.52	6.18	2.32	1.29	5.92	1.31	38.01
1893	2.65	6.33	4.10	3.41	5.82	2.09	1.01	4.01	2.72	5.01	2.38	4.34	43.87
1894	3.04	3.36	1.63	2.77	4.05	0.64	1.70	2.49	2.05	2.72	4.19	3.98	32.62
1895	4.06	0.95	3.20	4.68	2.40	3.47	5.40	3.41	3.62	7.13	8.19	3.75	50.26
1896	1.51	4.28	6.69	1.19	1.99	3.30	3.75	2.86	7.83	2.94	2.98	3.25	42.57
1897	3.25	2.65	3.64	2.38	4.31	2.83	7.72	3.93	1.69	1.07	6.67	4.52	44.66
1898	4.71	4.08	2.70	3.78	3.35	3.07	6.02	6.79	3.27	6.30	7.21	1.75	53.03
1899	4.77	4.17	6.20	2.32	1.51	4.03	4.11	1.84	3.95	1.13	2.39	1.77	38.19
1900	4.42	7.66	5.91	2.55	5.72	4.91	4.58	1.51	2.09	4.04	5.37	2.45	51.21
1901	1.40	1.06	6.53	6.84	6.45	1.28	4.20	5.36	4.43	3.62	2.47	9.43	53.07
1902	2.00	2.97	6.63	2.95	1.60	3.88	4.24	3.09	5.15	5.34	0.74	6.58	45.17
1903	3.30	4.44	7.23	2.68	0.73	7.25	2.98	4.45	2.16	3.40	2.10	3.29	44.01
1904	3.71	2.59	3.09	6.90	2.33	2.22	2.19	4.93	5.13	2.00	1.26	2.94	39.29
1905	3.97	1.61	2.78	2.91	1.01	3.84	0.95	4.48	6.67	1.91	2.51	3.87	36.51
1906	2.79	2.43	5.03	3.03	6.27	3.20	4.79	1.66	2.55	4.28	2.12	2.14	40.29
1907	4.80	1.88	1.74	2.83	3.27	3.71	2.18	0.82	8.41	4.91	5.89	4.93	45.40
1908	2.77	4.45	3.48	1.76	4.11	2.87	3.97	7.72	1.36	2.05	0.95	3.46	38 95
1909	2.79	5.88	3.30	5.10	2.35	1.63	1.95	2.48	4.69	1.26	1.86	2.66	35.95
1910	5.90	4.02	1.47	3.37	1.76	4.01	1.49	1.90	1.83	1.48	3.90	2.31	33.44
1911	2.95	2.60	3.47	2.80	0.23	1.57	3.44	5.51	5.04	3.71	5.35	3.39	40 06
1912	2.01	2.70	7.69	4.30	5.01	0.68	4.17	3.80	1.21	1.76	3.69	5.38	42.40
1913	3.12	2 96	6.27	4.74	2.84	2.36	1.67	4.73	4.14	6.35	1.82	4.15	45.15
Av.	3.31	3.41	4.38	3.36	3.32	3.01	3.41	3.82	3.74	3.35	3.64	3.71	42.46

RAINFALL AT EGREMONT (SOUTH), MASS. Elevation, 760 feet.

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1903	2.79	3.40	4.65	1.78	0.91	12.27	4.01	7.17	1.16	5.66	3.10	3.79	50.69
1904	2.61	2.03	3.63	4.53	2.98	10.17	2.44	6.71	5.42	2.55	2.22	2.82	48.11
1905	4.34	1.39	2.34	3.47	1.18	2.81	5.41	3.60	5.81	2.35	2.69	3.14	38.53
1906	1.98	2.04	4.45	4.12	3.54	4.17	5.79	2.85	2.80	3.57	1.95	3.89	41.15
1907	2.73	2.43	1.29	2.49	4.60	5.02	3.03	1.31	8.40	10.51	4.49	4.33	50.63
1908	3.32	3.90	2.09	2.66	4.58	1.89	5.32	4.72	1.30	2.04	0.75	2.82	35.39
1909	3.97	6.16	3.35	5.49	5.24	2.57	2.77	3.52	3.54	1.22	2.39	3.47	43.69
1910	6.04	4.16	1.65	4.66	5.00	3.21	1.89	4.15	2.41	1.18	4.37	2.14	40.86
Av.	3.47	3.19	2.93	3.65	3.50	5.26	3.83	4.25	3.86	3.64	2.75	3.30	43.63

RAINFALL AT FALL RIVER, MASS. Elevation, 210 feet.

(Water Works Pumping Station.)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1873	7.29	3.13	3.34	4.72	4.23	1.85	2.29	5.19	3.13	6.28	6.58	5.18	53.21
1874	3.46	3.17	2.10	9.45	4.86	4.05	3.59	9.92	3.68	1.83	2.43	3.08	51.62
1875	4.29	3.76	5.98	5.20	4.44	5.51	5.73	5.40	2 51	3.76	5.31	1.04	52.93
1876	1.31	5.76	8.57	5.93	3.19	1.53	4.73	1.36	3.80	1.92	11.08	5.46	54.64
1877	3.75	2.03	11.03	2.60	3.50	3.43	4.93	4.69	0.94	8.98	9.80	1.70	57.38
1878	7.76	4.40	4.97	4.65	2.61	2.92	2.59	2.70	1.94	7.15	6.62	7.02	55.33
1879	3 26	2.94	5.15	5.49	1.80	5.64	3.80	5 92	2.52	1.00	3.15	3 69	44.36

RAINFALL AT FALL RIVER, MASS. — *Continued.*

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1880	2.04	3.49	4.25	4.36	0.89	2.67	6.78	7.53	2.21	3.44	3.58	4.02	45.26
1881	7.11	6.64	5.86	2.10	3.58	6.20	2.47	0.81	2.77	2.05	5.86	2.90	48.35
1882	3.94	7.05	3.81	4.30	3.84	2.63	1.61	0.47	5.85	5.16	1.77	3.54	43.97
1883	5.05	4.49	1.92	3.08	3.06	1.34	5.11	0.48	2.90	5.33	3.88	3.00	39.64
1884	6.66	6.13	5.69	4.84	3.25	3.56	5.13	6.35	0.81	1.82	4.54	6.73	55.51
1885	5.99	3.19	1.92	2.60	3.55	3.31	1.11	4.07	1.58	4.93	3.16	3.24	38.65
1886	6.83	10.91	4.26	2.00	3.73	1.17	2.25	4.12	1.82	4.85	5.06	3.93	50.93
1887	7.16	5.31	5.55	4.06	2.58	5.04	3.95	3.91	1.44	3.89	2.88	5.05	50.82
1888	5.66	4.18	7.44	3.19	6.28	1.17	4.34	5.20	7.91	3.63	10.25	5.05	64.30
1889	7.19	2.94	3.33	4.68	4.68	3.08	5.95	6.09	4.69	4.79	9.35	2.82	59.59
1890	2.92	3.39	9.71	4.31	6.13	4.15	2.02	5.15	4.96	10.67	1.54	4.55	59.50
1891	10.45	6.90	7.17	3.52	2.31	1.76	2.73	2.70	1.81	6.02	3.42	4.30	53.09
1892	6.16	1.72	4.96	2.24	4.04	2.14	1.80	5.01	3.54	1.65	7.10	1.86	42.22
1893	3.02	6.29	2.98	3.08	4.26	2.84	1.52	6.33	3.17	4.66	4.12	6.47	48.74
1894	3.04	3.47	1.63	4.58	3.56	1.06	2.71	2.51	5.15	7.93	5.24	5.68	46.56
1895	4.05	0.66	4.02	4.74	4.17	2.99	3.88	3.08	1.66	5.06	8.65	3.03	45.99
1896	2.40	5.04	7.32	1.53	2.46	5.05	4.74	3.94	9.66	4.14	3.96	1.85	52.09
1897	4.47	2.17	3.01	4.30	4.08	3.18	5.16	6.08	2.02	1.29	9.45	4.83	50.04
1898	3.90	7.06	3.60	5.52	5.75	1.34	5.24	8.57	1.86	12.00	7.06	2.27	64.17
1899	5.84	4.11	7.44	2.92	1.82	4.46	3.37	1.85	7.90	2.39	2.44	1.45	45.99
1900	4.93	6.75	5.47	2.81	5.76	1.72	3.14	2.17	4.03	5.78	4.58	2.54	49.68
1901	2.43	0.91	7.90	9.58	9.06	1.78	2.98	2.75	2.70	3.44	2.46	10.16	56.15
1902	2.02	4.03	6.06	3.07	1.55	4.03	2.24	0.79	2.97	3.94	1.08	7.17	38.95
1903	3.98	4.31	7.77	4.79	1.83	5.25	2.25	3.83	0.87	4.12	2.13	3.07	44.20
1904	4.19	3.42	1.86	8.56	3.05	3.34	2.47	4.06	2.53	1.28	2.17	3.22	40.15
1905	2.80	1.61	2.48	2.07	1.31	5.08	2.94	4.84	3.92	2.05	2.71	3.97	35.78
1906	3.16	3.72	6.03	2.45	4.44	3.04	4.53	3.21	3.06	2.96	2.31	2.81	41.72
1907	3.75	2.09	1.71	3.19	4.11	1.98	0.88	1.22	6.41	2.20	5.08	4.61	37.23
1908	2.80	3.69	3.24	1.53	3.73	2.24	1.95	4.73	0.90	6.13	1.17	3.69	35.80
1909	4.45	5.03	3.19	5.69	2.99	1.48	0.44	2.16	3.12	1.76	3.80	2.84	36.95
1910	4.82	3.92	2.13	1.59	2.67	3.33	2.89	2.76	1.89	1.67	3.48	2.60	33.75
1911	3.48	1.86	2.50	2.96	1.83	1.45	5.05	2.39	2.59	2.05	6.25	2.98	35.39
1912	3.92	2.11	6.44	3.66	4.21	0.24	1.09	5.29	1.98	0.94	4.07	6.22	40.17
1913	4.45	3.69	3.01	5.85	1.61	1.05	3.17	2.89	2.50	9.73	2.13	3.81	43.89
Av.	4.54	4.08	4.80	4.09	3.58	2.93	3.31	3.96	3.21	4.26	4.68	3.99	47.43

RAINFALL AT FALMOUTH, MASS. Elevation, 60 feet.

(Wood's Hole.)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1873	4.76	4.92	3.15	4.63	4.32	1.01	1.56	3.07	3.86	5.54	9.05	6.23	52.10
1874	3.92	2.73	1.10	9.32	3.45	4.47	2.26	3.80	2.03	0.61	3.36	4.18	41.23
1875	4.20	2.88	5.34	3.95	4.52	2.23	4.68	2.37	2.79	3.62	4.77	1.23	42.58
1876	2.11	6.02	5.12	5.08	1.43	1.37	3.13	0.99	5.88	0.94	11.70	4.49	48.26
1877	2.83	2.84	10.78	4.20	2.39	2.22	5.69	5.42	0.28	6.97	6.08	1.20	50.90
1878	5.47	3.43	6.23	5.09	4.28	2.23	2.69	6.65	1.50	4.85	4.60	3.27	50.29
1879	3.36	1.98	4.39	4.78	1.35	2.31	3.91	4.81	2.22	1.37	3.54	2.86	36.88
1880	1.69	2.13	3.73	2.85	0.88	1.71	3.77	5.39	1.27	3.18	1.69	3.03	31.32
Av.	3.54	3.37	4.98	4.99	2.83	2.19	3.46	4.06	2.48	3.38	5.60	3.31	44.19

RAINFALL AT FITCHBURG, MASS. Elevation, 625 feet.

(Dr. Jabez Fisher.)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1865	2.45	1.26	4.14	2.27	7.70	2.28	1.58	2.19	0.27	5.19	3.76	2.14	35.23
1866	1.02	8.33	4.58	6.09	4.19	5.53	5.22	3.97	3.56	2.68	3.52	2.28	50.97
1867	1.47	2.76	1.76	2.80	4.03	6.52	4.35	10.72	0.64	3.02	2.57	1.28	41.92
1868	1.97	0.85	1.62	2.98	8.04	2.58	1.16	3.41	14.04	1.00	3.69	1.22	42.56
1869	1.78	3.14	3.73	1.98	5.37	4.45	2.16	1.72	4.08	13.01	2.15	3.44	47.01
1870	5.58	4.10	2.91	4.58	2.09	2.38	1.40	1.71	1.85	3.65	2.21	2.70	35.16
1871	1.14	1.95	2.81	2.37	2.72	5.48	2.30	4.30	1.41	4.72	3.44	1.23	33.87
1872	1.55	1.04	1.97	2.19	2.79	4.17	3.57	10.09	3.42	3.45	4.01	1.84	40.09
1873	3.21	1.41	2.24	1 03	3.90	0.09	5.91	4.90	4.07	7.34	2.27	2.42	38.79
1874	3.71	2.48	0.88	3.40	3.22	4.60	6.45	3.24	1.81	2.46	1.98	0.76	34.99
1875	1.45	2.77	3.19	5.23	4.20	3.97	3.07	5.71	2.83	5.58	3.24	0.58	41.82
1876	1.50	6.16	5.76	1.77	3.78	3.00	5.37	0.17	3.92	1.73	3.21	1.68	38.05
1877	1.70	0.34	6.15	2.94	2.73	2.45	3.40	2.40	0.44	7.04	5.64	0.82	36.05
1878	3.28	3.03	3.10	5.93	0.57	4.66	2.89	7.64	0.90	4.25	4.62	6.16	47.03
1879	1.48	2.45	2.78	2.12	2.74	7.20	4.08	7.32	2.34	0.65	2.49	3.23	38.88
1880	3.67	2.86	1.47	2.47	1.67	2.00	7.59	2.31	2.05	2.32	2.06	1.57	32.04
1881	2.73	2.87	3.36	1.05	3.45	4.15	2.73	1.93	1.40	2.48	3.75	3.94	33.84
1882	3.05	3.36	2.58	1.20	5.14	2.66	2.19	0.78	8.94	1.67	0.38	1.36	33.31
1883	2.15	2.90	0.99	1.49	3.54	2.94	2.74	1.42	1.47	4.45	1.50	1.86	27.45
1884	4.05	4.35	3.41	3.12	2.33	2.72	3.17	3.95	0.67	1.46	2.13	4.91	36.27
1885	5.03	2.90	0.38	2.23	2.24	1.36	1.85	8.63	1.57	3.41	5.61	2.39	37.60
1886	6.46	5.34	3.27	2.55	3.12	1.74	3.90	2.79	4.91	3.19	5.32	4.44	47.03
1887	6.12	5.04	4.79	4.84	2.77	3.34	7.23	9.38	2.45	1.99	3.39	4.04	55.38
1888	4.65	4.30	4.43	3.50	3.80	4.36	1.94	5.01	10.57	5.40	6.28	5.36	59.60
1889	5.73	1.72	1.97	3.12	3.28	2.62	7.17	2.31	3.35	5.08	6.22	3.22	45.79
1890	3.13	3.64	6.07	1.88	5.54	1.96	3.71	6.07	5.96	8.55	1.63	3.71	51.85
1891	7.06	4.56	5.17	4.26	1.79	3.48	3.95	2.48	1.87	3.73	2.97	4.26	45.58
1892	5.28	2.81	3.81	0.57	6.43	2.78	2.94	7.75	1.75	0.62	6.11	0.78	41.63
1893	2.30	6.89	2.77	2.78	8.25	2.65	1.54	7.58	1.60	5.03	2.48	4.95	48.82
1894	2.99	3.63	0.81	2.75	4.06	1.63	1.73	0.58	3.55	4.44	3.68	3.28	33.13
1895	3.32	1.28	2.55	4.73	2.32	3.24	6.26	2.09	2.70	7.10	5.88	3.78	45.25
1896	2.37	6.95	5.81	1.05	1.90	2.25	2.57	2.29	6.59	2.92	3.00	1.69	39.39
1897	2.61	2.42	2.66	1.35	4.86	5.09	12.68	2.50	2 37	1.03	7.33	6.39	51.29
1898	5.18	4.14	1.60	5.37	4.11	3.82	2.84	7.80	2.77	7.96	7 27	2.85	55.71
1899	3.27	3.59	6.87	1.07	1.38	3.35	4.47	2.87	4.72	1.93	2.18	2.03	37.73
1900	4.03	7.15	5.94	2.48	3.10	2.84	2.61	3.97	4.13	4.05	6.35	3.57	50.22
1901	4.77	0.77	5.06	9.91	7.46	1.19	5.13	4.50	1.73	3.52	1.67	8.46	54.17
1902	2.00	3.20	5.23	6.19	2.31	2.93	3.50	3.97	4.53	6.30	0.73	6.75	47.64
1903	2.68	3.59	5.86	3.69	1.20	10.34	3.05	3.43	2.29	1.87	2 00	3.88	43.88
1904	4.27	2.02	3.00	8.06	3.28	3.63	2.20	3.79	4.02	2.00	1.97	1.77	40.01
1905	5.65	1.52	3.96	2.03	1.34	6.49	4.20	5.25	6.25	1.96	1.97	3.23	43.85
1906	2.20	2.18	4.66	2.31	7.06	6.84	5.71	3.46	1.57	3.87	1.82	3.90	45.58
1907	2.22	1.51	1.74	1.92	2.71	5.06	4.09	1.23	9.30	4.72	6.63	3.39	44.52
1908	2.60	3.69	2.35	1.64	6.39	1.06	3.41	7.66	1.05	2.52	1.11	2.71	36.19
1909	3.20	5.49	3.30	4.19	2.43	3.06	1.70	3.20	4.05	1.31	2.60	3.07	37.60
1910	5.25	4.85	1.22	2.76	1.61	4.87	1.72	2.71	3.05	1.18	4.12	1.95	35.29
1911	2.54	2.09	3.45	1.66	1.16	3.04	2.36	6.64	2.29	5.70	3.43	2.77	37.13
1912	2.29	2.18	5.16	3.21	4.36	0.20	3.98	2.79	3.30	2.74	3.71	3.66	37.55
1913	2.39	2.64	4.96	2.82	3.63	0.71	1.49	4.43	4.79	5.65	2.14	2.65	38.27
Av.	3.28	3.28	3.43	3.10	3.63	3.46	3.70	4.23	3.45	3.84	3.43	3.07	41.90

RAINFALL AT FITCHBURG, MASS. Elevation, 550 feet.

(Dr. A. P. Mason.)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1885	...	3.13	1.04	3.29	3.10	1.68	2.45	9.55	1.53	4.10	5.85	2.85	....
1886	5.56	4.64	3.13	2.60	3.17	1.85	4.67	3.15	5.00	2.79	5.10	4.63	46.29
1887	4.93	5.45	4.31	5.09	2.70	3.47	7.09	9.77	3.30	2.08	3.63	4.26	56.08
1888	3.89	4.56	5.17	3.58	4.35	4.04	2.63	4.79	10.86	5.92	6.43	4.87	61.09
1889	4.86	1.72	1.83	3.07	3.34	2.92	7.35	3.02	3.77	5.77	6.74	3.48	47.87
1890	3.24	4.07	6.22	2.18	5.50	1.97	4.79	6.60	6.38	9.26	1.68	2.99	54.88
1891	6.95	4.19	5.15	4.17	1.76	3.44	3.52	2.46	1.88	3.37	2.68	4.02	43.59
1892	5.01	2.50	2.97	0.57	5.95	3.07	3.08	6.83	1.55	0.66	5.30	0.86	38.35
1893	2.39	6.23	3.24	2.78	6.83	2.22	1.56	8.95	1.54	4.92	2.33	4.70	47.69
1894	2.65	2.48	1.11	3.31	3.56	1.00	1.75	0.66	3.97	4.04	3.24	3.46	31.23
1895	3.75	0.92	2.84	4.85	2.11	3.50	2.92	2.16	2.38	7.86	4.53	3.90	41.72
1896	1.34	6.96	5.32	1.16	1.92	1.92	2.72	2.06	6.32	2.76	3.11	1.46	37.05
1897	3.22	2.86	3.83	1.81	4.41	4.37	8.88	3.08	1.94	0.91	6.91	5.70	47.92
1898	5.52	4.01	1.37	4.39	3.36	3.06	3.23	7.67	2.54	6.99	6.76	2.97	51.87
1899	3.47	3.19	7.36	1.64	1.12	4.29	4.23	2.34	4.82	1.62	2.09	1.76	37.93
1900	4.49	8.96	6.55	2.10	2.83	2.38	2.66	3.63	4.09	3.58	5.91	2.80	49.98
1901	1.70	0.75	4.98	8.98	6.94	1.10	6.03	4.14	1.63	3.46	1.49	8.30	49.50
1902	2.06	2.85	5.23	3.65	2.69	2.85	3.42	3.85	4.23	6.28	0.45	6.34	43.90
1903	2.65	3.61	5.14	2.49	1.05	8.98	3.08	3.06	2.46	4.10	2.13	3.26	42.01
1904	3.25	1.82	2.89	6.13	3.53	3.48	2.44	3.85	3.68	1.71	0.73	2.44	35.95
1905	5.56	1.44	3.96	2.28	1.35	5.60	4.62	5.38	6.10	1.94	2.04	3.17	43.44
1906	2.50	2.29	4.67	2.38	6.78	5.72	5.37	3.00	1.61	3.81	1.98	4.23	44.34
1907	2.69	1.64	1.68	2.62	2.54	3.51	3.44	1.13	8.90	4.87	4.96	3.63	41.61
1908	2.19	4.10	2.36	1.61	5.22	1.15	4.40	7.32	1.06	1.90	0.93	2.82	35.06
1909	2.93	5.71	3.62	4.43	1.98	2.84	2.48	3.08	4.11	1.34	1.82	4.01	38.35
1910	5.07	4.16	1.14	2.78	1.84	4.35	1.91	3.57	3.01	1.34	2.69	2.11	33.97
1911	2.49	2.11	2.98	1.63	1.80	2.83	2.52	6.48	2.37	4.64	3.41	3.01	36.27
1912	2.25	1.89	5.39	3.13	3.92	0.39	3.66	2.86	2.95	2.19	3.12	3.91	35.66
1913	2.52	2.31	4.68	2.94	3.28	0.44	1.74	4.96	5.03	5.26	2.30	2.44	37.90
Av.	3.54	3.48	3.90	3.16	3.42	3.10	3.79	4.28	3.84	3.76	3.37	3.63	43.27

RAINFALL AT FRAMINGHAM, MASS. Elevation, 160 feet.

(Metropolitan Water Works.)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1876	1.48	4.06	7.09	3.92	2.66	1.33	7.19	1.46	4.01	2.33	5.54	2.77	43.84
1877	3.01	0.26	8.19	3.44	3.94	3.05	2.67	3.34	0.34	7.94	6.12	0.92	43.22
1878	6.06	4.56	4.46	5.41	0.92	3.79	3.14	7.15	1.00	5.27	6.33	6.27	54.36
1879	2.56	3.76	4.47	4.58	1.46	3.25	3.61	6.16	1.68	0.86	2.61	4.83	39.83
1880	3.06	4.11	3.57	3.01	1.92	1.82	5.89	4.50	1.52	3.50	2.00	2.97	37.87
1881	5.42	4.57	5.29	1.88	3.29	4.86	3.06	1.37	2.28	3.01	3.94	3.71	42.68
1882	5.58	4.42	2.95	1.90	5.32	2.14	1.49	1.67	8.45	2.13	1.61	2.43	40.09
1883	2.85	3.61	1.69	1.98	3.83	2.02	2.76	0.54	1.51	5.81	1.90	3.45	31.95
1884	5.29	6.47	4.69	4.52	3.28	3.14	3.75	5.14	0.58	2.58	2.55	5.22	47.21
1885	4.95	3.82	1.01	3.69	3.52	2.97	1.29	7.18	1.51	5.71	5.98	2.42	44.05
1886	6.54	6.28	3.59	2.05	2.98	1.30	3.15	3.79	3.05	3.49	4.47	5.17	45.86
1887	5.20	5.07	4.96	1.60	1.06	2.42	3.81	4.62	1.29	2.87	2.64	3.91	42.45
1888	4.19	3.71	6.27	2.58	4.50	2.80	1.59	6.77	8.99	5.29	7.64	5.61	59.94
1889	5.36	1.68	2.46	3.59	4.05	3.42	9.34	4.49	4.61	4.65	6.28	3.15	53.08
1890	2.54	3.60	7.73	2.63	4.94	1.97	2.37	3.72	6.51	10.26	1.25	5.20	52.72

RAINFALL AT FRAMINGHAM, MASS.—*Continued.*

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1891	6.92	5.12	6.63	3.76	2.17	3.37	3.07	5.22	2.35	3.70	3.04	3.76	49.11
1892	6.00	3.20	4.01	0.85	5.57	2.75	4.22	4.48	2.59	1.28	5.81	1.14	41.90
1893	2.93	8.15	3.68	3.39	6.94	2.47	2.91	5.38	1.80	4.08	2.23	4.94	48.90
1894	4.23	3.91	1.41	3.28	4.37	1.11	3.82	1.94	2.78	5.20	3.43	4.81	40.29
1895	3.88	1.45	2.95	5.38	1.94	3.23	5.17	4.00	2.19	10.07	7.94	3.20	51.40
1896	2.43	5.85	5.91	1.85	2.83	3.14	2.14	2.74	7.39	3.84	2.92	2.17	43.21
1897	4.14	2.85	3.43	2.85	4.46	4.44	5.34	2.95	2.51	0.41	6.45	5.06	44.89
1898	6.54	4.27	2.40	4.73	3.05	2.24	3.98	7.42	2.09	7.01	7.24	3.30	54.27
1899	4.19	4.79	7.05	1.73	1.38	2.48	3.16	1.59	3.78	2.61	2.12	1.71	36.59
1900	4.64	8.82	6.21	2.48	4.22	2.91	2.24	2.25	3.41	3.78	5.37	2.54	48.90
1901	1.86	1.49	6.41	8.00	7.01	1.20	5.19	4.42	2.96	2.57	2.72	10.87	54.70
1902	2.71	6.65	6.45	4.62	1.79	2.42	2.97	4.07	4.34	4.20	1.36	6.61	48.19
1903	3.77	3.91	6.34	2.94	1.15	8.55	2.55	3.60	1.49	4.42	1.48	3.05	43.25
1904	4.70	3.00	2.69	8.78	2.44	2.70	2.14	3.41	5.64	1.51	1.73	2.96	41.70
1905	5.30	2.12	3.21	2.66	1.23	5.03	5.21	2.54	7.16	1.41	1.94	4.02	41.83
1906	2.50	2.88	6.13	2.72	5.25	3.38	3.13	2.64	2.91	3.11	2.50	4.39	41.54
1907	3.41	2.18	1.79	3.05	3.53	3.20	1.71	1.07	8.32	3.83	5.84	4.17	42.10
1908	3.24	4.22	3 67	1.75	5.41	0.74	3.43	4.36	0.96	2.52	0.89	2.95	34.14
1909	4.14	5.77	4.07	4.02	2.31	2 89	1.63	2.82	4.55	1.09	3.24	3.94	40.47
1910	4.98	5.10	0.77	2.72	1.34	4.81	1.76	2.26	2.57	1.88	4 02	2.43	34.64
1911	2.75	2.64	3.33	2.80	0.72	2.42	3.21	4.66	2.73	3.57	4.39	3.63	36.85
1912	2.84	2.64	6 33	4.12	4.20	0.38	3.35	2 92	1.70	2.58	3.54	5.02	39.62
1913	2.96	2.72	5.63	3.96	3.79	2.02	4.02	1.56	3.89	5.31	2.44	3.15	44.45
Av.	4.08	4.05	4.45	3.48	3.28	2.85	3.46	3.77	3.35	3.83	3.78	3.89	44.27

RAINFALL AT GARDNER, MASS. Elevation, 1 110 feet.

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1906	...	...	...	...	...	...	5.50	3.28	1.69	4.07	2.66	4.25	....
1907	2.18	1.31	1.90	2.64	3.06	3.52	3.96	1.09	9.81	5.59	5.74	4.01	44.81
1908	3.07	4.40	2.93	2.36	4.28	2.32	2 73	8.14	1.02	1.62	1.03	2.79	36.69
1909	4.13	5.40	3.49	5.24	2.58	2.10	4.34	2.81	4.82	1.21	2.27	3.28	41.67
1910	5.32	4.89	1.58	2.96	1.76	3.11	2.18	4.08	2.90	1.31	4.03	2.48	36.60
1911	2.98	2.26	3.83	2.13	1.13	2.91	3.98	7.07	2.41	5.35	3.82	3.59	41.46
1912	2.40	2.15	5.89	4.62	4.39	0.52	2.85	3.13	3.03	2.16	5.41	4.18	40.73
1913	2.40	2.69	5.58	3.36	4.53	0.58	1.57	3.97	3.77	5.24	2.96	3.06	39.71
Av.	3.21	3.30	3.60	3.33	3.10	2.15	3.09	4.33	3.97	3.21	3.61	3.34	40.24

RAINFALL AT GRANVILLE, MASS. Elevation, 750 feet.
(Westfield Water Works.)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1908	3.05	5.82	3.05	3.26	6.42	2.27	4.11	5.02	1.63	3.02	0 83	2.95	41.43
1909	4.06	6.23	4.76	6.38	3.45	2.26	2.19	6.28	3.80	1.22	2.73	3.90	47.26
1910	6.40	4.98	1.48	4.79	3.25	4.08	1.29	3.58	4.08	1.01	5.12	1.78	41.84
1911	2.06	2.09	3.31	2.55	1.15	4.01	4.40	6.94	4.95	10.10	3.00	3.44	48.00
1912	2.18	3.20	5.75	4.31	5.01	0.62	3.67	4.66	3.57	5.45	4.53	3.51	46.46
1913	3.50	2.28	4.42	3.46	5.23	1.00	1.52	3.20	3.47	8.99	3.93	2.18	43.18
Av.	3.54	4.10	3.79	4.13	4.09	2.37	2.86	4.95	3.58	4.96	3.36	2.96	44.69

RAINFALL AT GROTON, MASS. Elevation, 325 feet.

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1885	...	...	...	...	...	...	2.88	5.45	1.37	4.77	5.26	1.65	....
1886	5.41	5.09	1.17	2.20	3.15	1.54	3.82	3.86	4.83	3.17	3.70	2.36	40.30
1887	6.02	4.45	5.03	4.66	2.48	2.66	5.19	8.52	1.94	2.36	3.15	3.84	50.30
1888	3.00	4.15	5.84	3.85	3.41	2.83	2.40	4.20	10.42	6.43	5.32	4.64	56.49
1889	4.35	1.45	1.47	3.27	3.32	2.03	6.91	2.88	3.33	4.79	6.67	3.05	43.52
1890	2.85	3.84	6.11	2.17	5.01	3.08	4.20	6.37	6.50	9.63	1.57	3.28	54.61
1891	6.61	4.08	5.31	3.29	2.36	3.14	3.47	1.95	2.05	2.72	2.15	3.89	41.02
1892	4.64	2.62	2.54	0.65	6.19	3.58	2.64	5.73	1.60	1.10	5.69	0.87	37.85
1893	2.25	6.21	3.22	3.10	7.01	2.94	1.78	5.26	2.15	3.71	2.41	5.27	45.31
1894	2.44	2.77	1.18	3.35	3.96	0.89	2.09	0.74	3.85	4.04	3.95	2.89	32.15
1895	3.74	0.99	2.79	4.60	3.08	4.76	3.42	2.69	3.17	7.54	6.49	2.56	45.83
1896	2.14	5.60	5.85	1.85	2.15	2.29	3.04	2.67	7.30	3.61	2.72	1.81	41.03
1897	3.08	2.68	3.98	2.04	4.78	6.30	6.57	4.52	2.85	1.08	7.77	6.03	51.68
1898	5.67	4.66	1.83	5.35	3.54	3.10	3.05	8.94	3.41	8.13	6.20	2.57	56.45
1899	3.35	3.86	6.86	2.04	2.00	4.24	2.89	2.12	3.89	2.30	2.13	1.80	37.48
1900	4.63	9.51	6.91	2.05	3.69	3.99	3.21	3.90	4.12	3.34	5.84	2.95	54.14
1901	2.04	0.72	5.41	10.65	6.89	2.02	6.13	3.51	2.11	3.26	1.97	8.65	53.36
1902	2.29	3.99	4.53	3.95	2.60	2.14	3.91	4.20	4.40	6.38	0.97	6.39	45.75
1903	2.90	3.87	6.55	3.01	1.16	10.92	4.39	3.79	1.93	4.70	2.09	2.94	48.25
1904	4.10	1.48	3.05	8.60	4.80	2.83	2.68	3.53	4.26	1.25	1.03	1.90	39.51
1905	4.55	1.48	3.13	2.41	1.25	5.33	2.51	5.05	6.21	1.62	2.05	3.81	39.40
1906	2.68	2.64	4.79	2.96	6.09	6.51	3.99	2.07	1.53	2.67	2.97	4.18	43.08
1907	2.37	1.96	2.00	2.94	3.06	3.82	3.42	1.50	10.17	5.17	5.80	4.94	47.15
1908	3.56	4.58	2.83	1.89	4.76	1.08	2.78	5.61	0.81	2.22	**1.09**	2.85	34.06
1909	2.70	5.71	3.52	4.86	1.99	...	...	...	...	...	...	...	....
1913	2.19	2.44	4.47	2.96	3.33	0.91	1.69	2.68	4.17	6.46	1.65	2.65	35.60
Av.	3.62	3.55	4.03	3.49	3.75	3.46	3.59	4.01	4.04	4.07	3.56	3.59	44.76

RAINFALL AT HAVERHILL, MASS. Elevation, 125 feet.
(City Hall.)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1895*	5.10	1.50	2.90	3.65	2.10	3.30	3.85	2.90	2.40	7.45	5.80	3.20	44.15
1896*	2.50	5.60	7.20	1.40	2.50	2.00	3.20	2.60	7.20	3.15	2.60	1.90	41.85
1897*	4.20	3.60	3.60	1.80	4.20	6.00	3.80	2.60	2.90	2.50	4 70	5.10	45.00
1898*	2.90	6.70	1.10	5.50	3.30	2.40	2.00	6.70	2.40	7.80	3.50	4.50	48.80
1899*	3.60	4.40	8.10	2.20	0.70	2.60	3.50	2.00	4.50	2.60	3.00	0.90	38.10
1900	4.56	8.28	6.47	1.60	4.21	1.53	2.07	3.46	1.93	3 68	4.75	2.59	48.13
1901	1.21	0.70	4.23	8.98	6.88	1.16	3.41	2 76	2.04	2.98	2.82	8.35	45.52
1902	2.31	4.42	6.41	5.41	2.07	2.24	3.76	3.94	3.02	4.61	0.67	5.33	44.19
1903	2.93	2.89	5.52	3.60	0.67	9.37	2.35	3.43	1.89	3.14	1.21	3.18	40.18
1904	4.63	2.72	2.82	8.13	2.76	3.16	2.32	2.73	6.42	1.26	1.62	1.93	40.50
1905	5.77	1.66	3.00	2.80	1.23	7.04	1.29	2.58	5.82	1.05	1.95	4.68	38.87
1906	2.54	2.51	7.77	2.61	5.92	4.79	3.97	1.99	1.20	1.96	3.76	3.48	42.50
1907	3.84	1.80	1.78	2.99	2.04	2.79	4.53	0.86	7.20	4.12	5.39	3.36	40.70
1908	2.71	3.47	2.18	1.87	4.21	0.86	3.21	4.85	0.72	3.52	1.11	2.43	31.14
1909	3.85	4 57	3.08	4.20	1.72	1.23	1.85	2.45	4.51	0.97	3.89	3.85	36.17
1910	4.34	3.85	1.41	2.07	1.40	4.11	1.95	2.72	2.22	1.89	3.22	1.66	30.84
1911	2.13	2.65	3.55	1.74	0.53	2.63	5.02	4.39	2.04	2.41	3.72	3.20	34.01
1912	2.46	2.14	5.28	3.17	4.01	0.09	5.13	2.18	2.57	1.72	2.15	3.20	34.10
1913	2.05	1.89	3.94	3.04	3.48	0.90	0.95	2.57	2.44	7.89	1.83	3.82	34.80
Av.	3.35	3.44	4.23	3.51	2.84	3.06	3.06	3.04	3.50	3.40	3.04	3.51	39.98

* Rainfall at Kenoza Lake.

RAINFALL AT HINGHAM, MASS. Elevation, 70 feet.
(Henry W. Cushing.)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1885	...	...	...	...	...	....	...	...	1.40	3.80	5.72	2.47	...
1886	6.90	8.50	3.72	1.81	4.06	1.67	1.80	5.02	3.10	3.54	4.64	6.61	51.37
1887	7.34	5.00	5.12	4.62	2.49	3.49	5.22	3.62	1.24	2.98	2.46	4.67	48.25
1888	3.71	3.71	5.42	2.23	5.74	1.45	1.59	6.38	9.21	4.68	9.64	5.38	59.14
1889	7.43	2.28	2.82	4.13	3.37	3.57	7.52	4.45	4.67	5.13	6.11	2.47	53.95
1890	2.80	3.45	8.00	3.78	5.54	3.41	1.87	3.48	5.75	10.81	1.50	4.98	55.37
1891	7.58	5.98	5.78	3.12	1.90	4.37	3.21	4.73	2.27	6.22	2.94	3.59	51.69
1892	4.68	2.66	4.45	0.91	5.11	5.10	1.70	2.89	2.68	2.77	6.15	1.27	40.37
1893	1.88	6.76	2.90	2.96	4.73	2.35	2.32	5.33	2.02	3.10	2.50	5.11	41.96
1894	2.66	3.54	1.00	2.60	3.87	1.31	3.56	1.43	2.87	7.34	4.50	5.31	39.99
1895	3.23	1.20	3.10	4.47	3.50	1.27	4.99	4.93	2.09	7.04	7.11	3.67	46.60
1896	2.44	3.94	6.47	1.28	3.48	4.27	2.83	2.14	5.77	3.93	4.61	2.01	43.17
1897	3.61	2.31	2.58	3.26	4.41	3.22	4.11	5.24	2.51	0.79	7.17	3.79	43.00
1898	3.22	6.00	2.21	7.00	4.08	1.83	6.98	7.60	1.87	8.37	6.16	3.43	58.75
1899	3.87	4.67	6.84	1.04	1.14	2.84	4.41	0.98	8.52	3.97	1.72	1.35	41.35
1900	4.43	6.09	4.43	1.78	5.77	3.48	3.10	2.32	4.90	4.25	4.60	2.39	47.54
1901	2.65	1.12	6.91	7.73	7.04	1.25	9.43	2.75	3.97	3.62	3.35	9.08	58.90
1902	1.88	7.05	4.75	3.11	0.67	4.46	2.70	2.90	3.08	4.33	2.07	6.24	43.24
1903	3.69	4.54	7.69	6.49	0.24	4.54	3.66	4.28	1.17	5.76	1.74	2.85	46.65
1904	6.20	3.91	2.06	8.18	2.88	2.72	2.01	2.78	6.17	2.60	2.41	3.07	44.99
1905	3.84	1.65	2.93	2.68	1.04	4.78	2.63	2.70	4.91	1.57	2.04	5.06	35.83
1906	3.21	4.03	6.53	1.91	4.79	1.41	6.92	2.06	4.11	4.75	3.10	3.85	46.67
1907	3.21	3.20	1.57	4.56	3.17	3.02	1.78	1.68	10.43	2.99	6.86	5.66	48.13
1908	2.60	4.14	3.39	1.45	3.92	1.28	5.03	3.38	1.60	6.43	1.11	3.39	37.72
1909	5.34	4.98	3.76	5.09	2.38	2.98	0.77	3.63	4.95	1.56	5.51	2.95	43.90
1910	4.83	4.25	2.19	2.37	1.82	3.69	2.28	1.70	2.11	1.70	5.33	2.63	34.90
1911	2.89	3.21	3.54	2.86	0.42	3.70	5.53	6.07	3.24	3.01	6.16	3.25	43.88
1912	2.77	2.49	4.79	3.70	3.72	0.78	4.65	2.51	2.17	1.13	3.68	6.18	38.57
1913	3.42	2.86	5.03	6.20	2.30	2.31	2.48	2.68	2.41	7.81	2.42	3.66	43.58
Av.	4.01	4.05	4.29	3.62	3.34	2.88	3.75	3.56	3.92	4.36	4.20	4.07	46.05

RAINFALL AT HINGHAM, MASS. Elevation, 100 feet.
(Hingham Water Company.)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1897	3.99	2.18	3.04	3.57	3.58	4.38	5.69	5.57	2.05	0.73	6.85	4.01	45.64
1898	3.13	7.16	2.64	7.38	4.55	1.71	6.73	8.46	2.17	9.21	6.34	2.98	62.46
1899	5.40	4.76	7.07	1.49	1.29	2.62	4.34	1.18	8.91	2.36	3.37	1.63	44.42
1900	4.84	6.73	4.77	1.90	5.81	3.55	3.41	2.18	4.96	4.19	5.29	2.75	50.38
1901	2.39	0.93	7.13	7.82	6.91	2.04	7.77	2.26	3.86	4.16	2.85	9.07	57.19
1902	1.99	6.92	5.12	3.31	1.21	4.16	2.61	2.75	2.82	4.82	1.79	6.35	43.88
1903	4.02	3.72	8.55	6.55	0.59	5.89	3.38	4.15	1.12	5.49	1.60	3.38	48.44
1904	5.97	3.91	2.76	8.69	3.41	3.10	2.35	3.06	6.00	2.85	2.16	2.62	46.88
1905	3.97	1.83	2.39	3.13	1.08	4.64	2.67	2.51	4.70	1.56	2.00	4.95	35.43
1906	3.17	3.76	7.13	2.34	4.71	2.78	6.36	1.64	3.77	5.10	3.07	4.37	48.20
1907	3.21	3.12	1.83	3.64	3.17	2.32	1.15	1.45	9.91	3.33	6.66	5.14	44.93
1908	2.94	4.18	3.43	1.69	3.98	1.24	5.15	3.64	1.78	5.97	1.13	3.35	38.48
1909	5.08	5.24	4.37	4.93	2.61	3.01	1.09	3.41	4.62	1.43	5.56	3.36	44.71
1910	4.38	4.20	1.93	2.52	1.69	4.16	2.32	1.33	2.02	1.61	5.27	2.58	31.01
1911	2.86	2.79	3.42	2.75	0.31	3.58	5.94	5.69	2.68	2.70	6.40	3.34	42.46
1912	4.25	2.62	5.07	3.78	3.92	0.35	4.57	2.88	1.42	1.41	3.61	6.28	40.16
1913	3.65	3.56	3.84	4.32	2.43	1.95	2.96	2.50	2.58	7.36	2.52	3.82	41.49
Av.	3.84	3.98	4.38	4.11	3.01	3.03	4.03	3.21	3.84	3.78	3.91	4.12	45.24

RAINFALL AT HOLDEN, MASS. Elevation, 750 feet.
(Jefferson, Metropolitan Water Works.)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1897	3.95	3.03	3.92	2.18	4.84	4.95	8.48	2.71	1.70	1.00	8.03	6.87	51.66
1898	6.74	3.33	2.59	4.10	3.32	3.38	3.00	11.89	3.15	7.28	7.50	4.13	60.41
1899	2.92	5.08	6.90	2.13	1.28	7.37	4.82	3.40	3.84	2.84	1.93	2.12	44.63
1900	4.39	8.60	6.35	3.12	4.62	3.98	3.53	2.79	2.77	3.35	6.77	3.20	53.47
1901	1.91	1.39	6.02	9.44	7.33	2.25	5.55	4.92	2.93	3.96	2.32	9.35	57.37
1902	2.96	5.01	5.36	4.01	1.60	2.44	3.96	5.50	4.18	6.76	0.95	7.21	49.94
1903	2.84	4.20	6.85	2.95	1.27	9.01	3.07	3.89	3.24	3.83	2.52	4.27	47.94
1904	4.53	2.80	3.50	7.25	3.43	3.78	4.76	3.54	5.72	1.92	1.58	2.98	45 79
1905	5.93	1.73	4.27	2.39	0.82	5.74	3.83	3.16	6.64	1 93	2.87	4.09	43.40
1906	2.86	2.81	5.42	3.56	7.18	5.95	5.52	4.55	2.94	4.73	2.04	4.28	51.84
1907	2.95	2.37	1.87	3.04	3.14	3.49	3.09	1.37	9.70	6.51	6.02	4.82	48.37
1908	3.80	5.13	3.10	3.14	5.52	1.41	4.10	6.49	1.21	2.15	1.27	3.17	40.49
1909	4.14	6.29	4.57	5.66	2.31	3 22	5.29	4.22	4.13	2.03	1.89	4.41	48.16
1910	6.99	5.58	1.23	3.09	1 89	3.86	1.16	3.98	2.78	1.23	4.21	2.73	38.73
1911	3.19	2.63	4.11	2.42	1.91	2.24	2.70	5.83	3.08	5.79	4.11	3.06	41.07
1912	2.72	2.52	5.66	4.37	5.14	0.52	2.77	2.48	2.49	2.18	4.19	5.24	40.28
1913	3.52	2.60	6.28	3.96	4.09	1.27	3.67	3.26	5.93	6.42	2.64	3.13	46.77
Av.	3.90	3.83	4.59	3.93	3.51	3.81	4.08	4.35	3.91	3.76	3.58	4.42	47.67

RAINFALL AT HOLDEN, MASS. Elevation, 1 000 feet.
(Kettle Brook, Worcester Water Works.)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1905	4.40	1.23	5.52	3 00	0.99	5.96	3.20	2.99	7.29	1.94	3.00	4.45	43 97
1906	2.48	3.31	3.18	2.70	7.07	3.47	6.81	5.29	2.78	3.65	2.45	3.68	46.87
1907	3.32	2.27	1.48	2.70	4.08	4.08	1.86	1.49	10.49	7.68	7.05	4.24	50.74
1908	3.96	4.68	3.25	2.38	6.10	1.98	5.90	6.99	1.99	4.12	1.39	2.01	44.75
1909	2.78	6.76	4.32	6.55	3.05	2.56	2.46	3.58	3.90	1.73	2.22	4.16	44.07
1910	6.59	4.55	1.43	3.68	1.56	4.04	1.88	4.02	3.13	1.07	4.77	1.82	38.54
1911	2.28	2.32	4.29	2.42	1.74	2.53	3.15	4.81	5.08	6.32	4.26	2.94	42.14
1912	2.33	2.78	5.97	5.12	5.52	0.68	3.38	4.41	2.00	2.05	4.93	4.83	44.00
1913	3.19	3.46	5.42	4.97	4.68	2.08	2.74	2.72	5.66	7.20	3.17	3.65	48.94
Av.	3.48	3.49	3.87	3.73	3.87	3.04	3.49	4.03	4.70	3.97	3.69	3.53	44.89

RAINFALL AT HOLDEN, MASS. Elevation, 750 feet.
(Holden Reservoir No. 1, Worcester Water Works.)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1885	3.60	2.71	1.12	2.68	2.83	2.87	2.83	6.70	1.63	5.11	6.80	2.78	41.66
1886	6.83	7.15	3.66	1.58	2.99	2.03	4.28	4.87	3.62	2.50	5.33	3.00	47.84
1887	4.82	4.89	...	...	0.82	2.50	8.04	9.95	1.10	2.46	2.97	1.38	...
1888	3.60	4.35	6.23	3.00	4.27	2.93	2.25	5.79	8.85	6.97	3.27	5.89	57.40
1889	5.40	1.53	1.39	2.04	3.07	2.88	7.26	1.28	3.65	3.52	6.45	2.88	41.35
1890	2.68	3.94	3.15	1.26	4.93	2.93	3.50	6.29	5.97	9.78	1.26	3.33	49.02
1891	6.72	4.85	4.79	2.31	1.91	3.47	3.77	4.63	2.24	3.03	3.21	5.04	45.97
1892	4.89	1.74	2.08	0.19	6.21	2.49	5.13	6.68	1.50	0.58	5.58	0.43	37.50
1893	2.49	5.03	3.83	3.40	6.35	2.22	1.21	2.77	2.10	4.85	2.09	4.32	40.66
1894	3.02	2.98	1.22	3.17	4.37	0.15	2.36	1.15	2.58	3.37	2.90	2.92	30.19
1895	4.00	0.85	2.22	5.43	3.29	4.33	5.05	3.28	2.64	7.40	8.14	3.62	50.25
1896	1.30	3.77	7.47	0.65	3.02	2.70	4.83	2.24	7.73	3.15	3.06	1.68	41.60
1897	4.80	2.47	3.86	2.76	4.24	4.65	7.83	3.09	1.59	0.65	6.59	5.88	48.41
1898	4.39	4.18	2.21	3.54	2.99	2.65	2.32	9.53	3.17	6.03	6.76	2.66	50.43
1899	3.66	4.13	5.75	1.81	1.01	5.34	3.79	3.01	3.53	1.48	2.37	1.97	37.85
1900	4.15	8.76	7.24	2.69	4.04	3.37	5.19	2.47	2.45	4.44	7.12	1.94	53.86
1901	1.89	1.52	6.45	9.86	7.26	1.42	5.37	4.44	3.49	4.79	3.13	10.09	59.71
1902	2.84	2.57	6.68	4.12	1.94	2.61	3.69	3.65	3.96	6.18	0.97	7.11	46.32
1903	3.11	3.94	6.83	2.95	1.24	10.10	4.48	4.31	2.28	4.01	2.65	4.13	50.03
1904	4.38	2.68	3.41	7.35	2.52	3.60	4.00	4.06	4.83	2.13	1.54	2.60	43.10
1905	5.24	2.37	4.28	2.91	1.01	6.17	2.62	2.66	7.29	2.00	2.90	4.08	43.53
1906	2.76	2.93	5.41	3.20	5.88	3.72	7.79	2.93	2.76	4.37	2.59	3.81	48.15
1907	3.26	2.28	2.20	3.31	3.51	3.48	3.07	1.50	10.48	5.89	5.78	5.07	49.83
1908	2.98	5.01	3.34	2.40	4.33	1.72	4.91	6.47	1.52	1.92	1.05	3.34	38.99
1909	2.98	6.36	4.31	6.48	2.54	2.84	2.19	3.39	3.94	1.75	2.04	3.64	42.46
1910	5.77	3.98	1.46	3.61	1.75	2.48	1.82	4.39	3.19	1.29	4.23	2.66	36.63
1911	3.03	2.38	4.09	2.29	2.06	2.35	3.23	5.40	4.11	5.53	4.60	3.17	42.24
1912	2.34	2.67	6.31	5.28	5.76	0.48	3.37	3.93	2.30	2.01	5.03	5.12	44.60
1913	3.21	3.22	5.94	4.72	4.67	1.98	2.31	2.51	7.32	6.76	2.79	3.23	48 66
Av.	3.76	3.58	4.18	3.39	3.57	3.14	3.95	4.05	3.95	3.98	3.94	3.80	45.29

RAINFALL AT HOLYOKE, MASS. Elevation, 230 feet.
(Whiting Street Reservoir, Holyoke Water Works.)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1907	2.51	2.40	2.00	2.64	4.80	3.47	3.76	1.38	9.78	5.27	4.83	4.04	46.88
1908	2.65	4.79	2.50	2.54	6.28	1.86	3.17	5.98	0.18	2.21	0.73	2.87	35.76
1909	2.99	5.59	3.77	5.86	2.84	2.62	1.58	4.64	4.40	1.07	2.31	3.75	41.42
1910	6.68	5.41	1.54	3.82	2.79	3.89	1.48	2.98	3.29	0.89	3.32	1.43	37.52
1911	1.95	1.85	3.72	1.74	1.15	2.40	6.10	6.40	3.77	8.40	3.12	3.13	43.73
1912	1.70	1.05	5.76	4.82	5.21	0.59	1.84	2.99	2.62	3.02	3.66	3 23	36.49
1913	3.20	2 28	5.89	3.23	5.58	0.61	1.10	2.77	3.07	6.10	2.39	2.45	38 67
Av.	3.34	3.10	3.60	3.52	4.09	2.20	2.72	3.88	3.87	3.85	2.91	2.99	40.07

RAINFALL AT HOLYOKE, MASS. Elevation, 450 feet.

(High Service Reservoir, Holyoke Water Works.)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1907	3.01	2.08	1.90	1.88	3 56	3.61	1.91	1.23	8.66	5 85	4.90	3.92	42.51
1908	2.88	4.79	2.83	1.39	6.80	1.88	4.52	5.45	0.15	2.34	0.71	1.97	35.71
1909	3.25	5.29	3.63	6.21	2.71	2.08	1.63	4.97	3.94	1.30	2.81	3.40	41.22
1910	6.11	4.38	1.60	4.13	2.90	3.96	1.24	2.46	3.11	0.79	4.08	1.76	36.52
1911	2.27	1.72	3.64	2.26	0.87	3 06	5.71	6.52	3 83	8.73	3.31	2.97	44.89
1912	1.50	3.02	5.90	4.67	5.82	0.52	1.96	4.96	2.46	3.40	4.06	3.75	42.02
1913	3 03	2.30	6.24	3.22	5.34	1.06	1.16	2.14	2.43	6.62	2.41	2.60	38.55
Av.	3.15	3.37	3.68	3.39	4.00	2.31	2.59	3.96	3.51	4.15	3.18	2.91	40.20

RAINFALL AT HOLYOKE, MASS. Elevation, 330 feet.

(Ashley Pond, Holyoke Water Works.)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1907	3.18	2.25	1.88	1.94	3.90	3.69	2.25	1.33	8.89	5.73	4.98	4.05	44.07
1908	3.04	4.74	3.02	1.55	1.82	2.15	4.74	5.57	0.18	2.37	0.83	2.75	32.76
1909	2.97	5.78	3.57	6.29	2.76	2.26	1.94	5.01	4.36	1.45	2.86	3.41	42.66
1910	6.40	4.50	1.70	3.94	3.06	3.84	1.24	2.41	3.31	0.87	4.03	1.79	37.09
1911	2.21	1.83	3.69	2.05	0.99	2.94	6.11	6.37	3.84	8.85	3.48	3.08	45.44
1912	1.48	3.08	6.00	4.80	5.27	0.48	1.89	5.22	2.46	2.96	3.99	4.13	41.76
1913	3.06	2.07	6.11	3.10	5.12	0.85	1.06	2.98	2.49	6.35	2.50	2.66	38.35
Av.	3.19	3.46	3.71	3.38	3.27	2.32	2.75	4.13	3.65	4.08	3.24	3.12	40.30

RAINFALL AT HOLYOKE, MASS. Elevation, 90 feet.

(Holyoke Water Power Co.)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1897	...	...	...	...	...	...	15.77	5.91	1.58	0.65	6.81	5.27	...
1898	5.73	5.38	1.48	4.74	5.31	3.30	3.78	6.97	2.37	6.16	5.28	2.69	53.19
1899	3.70	2.47	6.84	3.46	1.64	4.12	6.54	1.08	4.48	2.06	2.78	2.22	41.39
1900	3.50	8.85	5.03	1.44	4.28	2.52	2.74	2.40	2.87	3.43	6.04	3.19	46.29
1901	1.96	0.63	6.18	7.72	7.12	1.17	3.28	6.94	2.97	3.89	1.63	7.29	50.78
1902	1.83	2.67	6.42	3.40	1.80	3.66	4.06	4.82	5.48	5.88	1.31	8.25	49.58
1903	3.16	4.59	6.55	2.57	1.30	8.13	3.53	6.35	2.09	2.91	2.25	3.80	47.23
1904	4.29	2.35	4.29	6.36	3.51	2.93	3.99	3.75	4.44	2 29	1.26	2.96	42.42
1905	4.85	1.60	3.89	2.72	0.84	3 61	2.21	5.09	6.72	1.86	2.14	3.68	39.21
1906	2.55	2.81	5.68	3.55	5.94	4.83	4.60	1.92	3.12	5.43	2.56	2.56	45.55
1907	4.29	2.58	1.96	2.67	3.85	3.34	3.16	1.17	9.43	5.52	4.66	4.31	46.94
1908	3.21	5.16	3.13	1.74	6.55	1.95	6.07	7.24	1.09	2.46	0.89	2.95	42.44
1909	4.07	6.10	3.77	6.06	3.06	2.10	2.00	4.66	4.37	1.28	2.89	3.51	43.87
1910	6.69	4.99	1.74	3.48	2.69	3.76	1.49	2.63	4.02	0.73	3.73	1.73	37.68
1911	2.25	1.78	3.41	2.15	0.53	2.54	8.76	5.80	4.54	8.94	3.58	2.98	47.26
1912	2.34	3.18	6.42	5.23	5.04	0.45	2.16	3.95	2.24	2.76	3.72	4.34	41.83
1913	2.94	2.69	6.02	3.68	5.04	0.75	0.96	3.45	2.59	6.41	2.16	2.99	39.68
Av.	3.58	3.61	4.55	3.81	3.66	3.07	3.71	4.26	3.93	3.88	2.93	3.72	44.71

RAINFALL AT IPSWICH, MASS. Elevation, 100 feet.

(Rev. Manasseh Cutler.)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1782	...	...	...	...	...	...	...	...	0.70	3.13	4.53	3.60	....
1783	4.03	4.91	1.73	1.01	4.00	3.44	9.06	4.44	1.45	11.61	5.67	4.93	56.28

RAINFALL AT LAKE COCHITUATE, MASS. Elevation, 140 feet.

(Metropolitan Water Works.)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1852	5.80	1.76	4.42	9.60	2.60	2.00	2.16	8.27	2.04	3.40	2.76	3.12	47.93
1853	3.68	6.56	2.92	3.80	6.32	0.56	2.84	7.20	5.44	4.56	5.26	6.59	55.73
1854	2.45	5.16	4.16	5.60	3.92	2.08	2.32	0.28	3.68	3.37	7.79	2.34	43.15
1855	4.52	3.50	1.91	2.65	0.82	1.98	3.86	0.77	0.75	4.16	4 84	5.20	34.96
1856	1.44	0.22	0.66	4.27	7.81	1.77	1.76	11.40	3.13	2.34	1.43	4.57	40.80
1857	2.51	1.30	1.72	10.23	7.15	4.02	8.85	6.62	4.27	7.06	3.07	6.30	63.10
1858	2.61	3.32	3.87	4.39	2.23	10.17	3.46	6.42	5.17	2.12	2.91	1.99	48.66
1859	5.64	2.91	10.95	1.37	3.46	3.16	0.99	7.69	4.56	0.33	3.55	4.41	49.02
1860	1.24	3.80	1.98	2.25	1.98	11.16	6.82	4 89	9.92	1.72	5.97	3.71	55.44
1861	2.51	3.81	2.75	6.44	3.12	2.64	1.62	7.79	2.76	3.20	6.20	2.60	45.44
1862	7.82	1.08	4.18	1.85	2.71	6.58	6.54	1.43	2.62	4.83	7.69	2.36	49.69
1863	4.10	4.38	3.57	11.34	2.66	1.98	14.12	5.61	3.39	4.56	8.54	5.05	69.30
1864	3.37	0.98	8.44	4.02	2.84	0.58	1.06	3.56	1.52	6.50	5.45	4.28	42.60
1865	4.99	4.45	5.48	2.18	8.25	0.91	3.10	3.36	1.66	6.99	4.78	3.31	49.46
1866	1.44	5.80	3.92	1.94	6.46	4.80	13.35	3.98	8.36	3.43	4.52	4.32	62.32
1867	2.76	5.40	5.65	2.43	6.46	2.95	5.36	12.36	1.08	7.27	2.63	1.90	56.25
1868	3.70	1.18	2.51	5.61	8.12	2.95	2.16	7.38	7.69	1.19	6 77	0.45	49.71
1869	3.71	7.07	7.52	2.57	7.59	3.68	2.63	2.34	8.49	9.50	3.26	5.98	64.34
1870	7.85	4.68	6.04	8.81	3.14	4.05	3.10	2.03	0.64	7.96	4.40	3.19	55.89
1871	1.31	2.30	5.02	2.29	5.66	5.96	2.20	3.56	1.46	5.38	7.01	3.24	45.39
1872	1.86	1.37	3.06	1.74	3.24	4.27	5.55	9.76	6.29	3.69	4.22	3.42	48.47
1873	4.24	2.43	3 98	2.69	3.21	0.38	4.08	7.17	2.62	6.11	4.54	3.95	45.43
1874	2.96	2.90	1.19	6.36	3.40	4.79	3.16	4.83	1.55	1.04	2.05	1.70	35.93
1875	2.42	3.15	3.74	3.23	3.56	6.24	3.57	5.53	3.43	4.85	4.83	0.94	45.49
1876	1.83	4.21	7 43	3.24	2.80	1.60	9.49	2.19	3.98	2.00	6.59	3.13	48.49
1877	3.19	0.53	7.79	3.24	3.73	2.64	2.77	3 35	0.46	8.14	6.94	1.02	43.80
1878	5.77	5.93	4.20	5.63	0.83	3.33	3.47	6.94	1.12	5.15	6.09	5.12	53.58
1879	2.00	3.05	3.90	4.69	1.20	4.14	3.38	6.43	1.74	0.90	2.98	3.60	38.01
1880	3.07	4.05	2.83	2.94	1.98	1.25	7.00	3.81	1.69	2.95	1.70	2.56	35.83
1881	5.56	4.43	4.79	1.71	3.18	4.83	2.78	1.13	2.13	2.87	3.85	3.83	41.09
1882	5.93	3.96	2.76	1.89	4.73	1.87	3.49	1.14	9.20	2.22	0.93	2.17	40.29
1883	2.88	3.59	1.76	2.27	3.95	1.81	2.88	0.39	1.31	5.16	2.06	3.14	31.20
1884	4.39	6.04	4.50	3.80	2.92	3.88	4.42	4.49	0.90	2.59	2.33	5.31	45.57
1885	5.25	3.98	1.09	3.71	3.46	2 96	1.73	7.01	1.63	5.26	5.26	2.32	43 66
1886	6.53	6.86	3.46	2.00	2.97	1.21	3.30	3.75	3.20	3.16	4.76	5.77	46 97
1887	5.29	5.34	5.10	4.45	1.02	2.58	3.77	3.70	1.28	2.49	2.76	3.80	41.58
1888	4.13	3.55	5.60	2.51	4.63	2.07	1.67	6.32	8.81	4.95	7.03	5.66	56 93
1889	5.46	1.56	2.28	3.19	3.64	3.17	9.10	4.57	4.92	3.85	5.79	2 70	50.23
1890	2.34	3.21	7.35	2.51	5.31	1.78	2.31	3.34	6.47	10.11	1.24	5.26	51.23
1891	6.67	5.02	5.49	3.62	1.67	3.78	2.99	4.91	2.12	4.14	2.84	3.17	46.42
1892	4.78	2 80	4.12	0.78	5.46	3.23	3.47	3.79	2.87	1 42	5.14	1.18	39.04
1893	2.61	7.26	3.13	3.21	5.45	2.75	2.40	5.86	1.76	3.74	2.08	5.03	45.28
1894	3.95	3.89	1.16	3.27	3.70	1.61	3.61	2.57	2 27	5.14	3.53	4.38	39.08

RAINFALL AT LAKE COCHITUATE, MASS. — *Continued.*

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1895	3.93	1.70	3.11	5.03	2.03	3.12	4.71	3.96	2.77	9 57	6.32	2.71	48 96
1896	2.43	6.70	5.20	1.60	2.27	3.04	2.22	2.43	8.21	3.53	3.00	2.15	42.78
1897	4.23	2 86	3.60	2.78	4.25	4.28	4.80	3.26	2.56	0.89	6.47	4 81	44.79
1898	6.83	4.29	2.54	5.07	3.07	2.08	3.55	7.08	3.03	6.82	6.91	3.44	54.71
1899	4.36	4.44	7.31	1.70	1.06	2 79	3.20	2.17	4.65	3.05	2.31	1.92	38.96
1900	4.96	8.59	5.82	2.24	4.77	3 02	2.65	3.58	3.84	3.65	5.52	2.67	51.31
1901	1.85	1.80	6.35	7.51	6.93	1.26	6.67	4.48	3.17	2.83	3.03	8.58	54.46
1902	2 11	6.67	5.04	3.66	1.24	2.42	3.53	3.39	4.91	4.05	1.37	6.22	44.61
1903	3.81	3.88	6.30	3.17	1.56	7.61	3.00	4.20	1.31	4.27	1.53	3.18	43.82
1904	4.75	3.11	2.78	8.68	2.14	2.86	1.80	3.32	6.78	1.66	1.84	2.39	42.11
1905	5.40	2.00	3.28	2.87	1.57	5.46	3.24	2.89	7.00	1.35	2.07	4.07	41 20
1906	2.66	2.59	6.47	2.60	4.98	3.44	3.04	2.37	2 84	3.26	2.50	4.68	41.43
1907	3.14	2.18	1.88	3.47	3.62	2.89	1.45	1.27	7.62	3.96	5.63	3.66	40.77
1908	3.33	4.30	3.62	1.80	4.58	0.82	3.91	3.98	0.77	2.37	0.85	2.70	33.03
1909	4.34	5.66	3.46	4.01	1.76	3.09	1.73	2.84	4.33	1.06	3.70	4.10	40.08
1910	5.11	5.16	0.77	2.71	1.33	4.51	2.23	1.58	2.50	1.80	4.16	2.61	34.47
1911	2.74	3.20	3.31	2.73	0.65	2.53	3.42	4.82	2.96	3.53	4.28	3.74	37.91
1912	3.10	2.51	6.38	4.16	5.23	0.47	2.87	2.26	1.82	2.99	3.24	4.96	39.99
1913	2.89	2.80	5.59	4.05	3.70	0.86	3.03	4.36	3.67	5.80	2.23	3.05	42.03
Av.	3.85	3.76	4.21	3.81	3.65	3.17	3.87	4.42	3.63	4.00	4.12	3.64	46.13

RAINFALL AT LAKEVILLE, MASS. Elevation, 60 feet.

(Assawompsett Pond, Taunton Water Works.)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1894	3.61	2.58	1.35	3.66	4.31	0.99	1.37	1.22	3.26	7.16	4.29	4.76	38.56
1895	3.36	0.71	3.46	4.97	3.33	2.60	2.58	3.28	1.84	4.53	6.67	3.08	40.41
1896	2.08	4.02	5.98	1.05	2.96	3.95	2.22	4.43	8.77	4.42	3.67	2.37	45.92
1897	4.09	2.22	2.61	4.18	3.94	2.61	4.56	3.50	1.58	1.05	7.66	3.74	41.74
1898	4.10	6.38	2.68	5.44	5.25	1.34	5.15	6.67	2.30	9.39	6.29	2.21	57.20
1899	5.24	4.26	6.91	2.19	1.90	3.63	2.90	2.23	7.46	2.06	2.23	1.47	42.48
1900	5.17	7.56	5.42	2.16	6.87	2 67	3.06	2.43	5.08	3.97	4.87	2.19	51.45
1901	2.63	0 87	7.49	6.49	8.15	1.81	2.99	2.68	3.18	3.19	2.18	9.08	50.74
1902	2.31	4.58	7.29	2.17	2.98	4.96	2.00	1.61	3.07	5.38	1.44	6.59	44.38
1903	4.56	4.16	9.16	5.70	0.80	4.30	2.82	3.93	1.05	5.05	2.01	4.10	47.64
1904	4.66	4.16	2.61	9.68	2.39	4.07	2.92	3.61	4.03	2.01	2.41	3.28	45.83
1905	3.70	1.94	2.28	2.26	1.39	7 60	4.86	2.68	5.27	2.13	2.33	4.19	40.63
1906	3.25	4.49	6.11	2.68	4.30	3.30	5.49	1.43	3.27	3.22	3.10	2.81	43 45
1907	4.45	2.28	1.28	3.85	3.87	2.29	1.35	1.55	9.76	3.21	5.85	5.94	45.68
1908	3.74	4.53	3.60	1.69	3.81	2.07	3.18	4.79	1.11	6.67	1.14	4.31	40.64
1909	4.48	6.48	4.17	6.06	3.06	1.54	1.18	2.39	4.60	1.84	4.07	3.49	43.36
1910	5.42	4.20	1.81	2.01	2.84	5.21	3.41	1.96	1.99	1.98	4.72	2.94	38 49
1911	3.49	2.46	4.24	3.59	1.89	1.86	5.33	3.60	2.73	2.41	7.41	4.16	43.17
1912	4.20	3.44	8.55	3.41	4.53	0.28	2.17	3.49	1.13	1.40	4.71	5.52	42.83
1913	4.50	4.08	3.29	5.53	1.85	1.58	1.89	2.96	2.48	12.56	3.08	**3 64**	47.44
Av.	3.95	3.77	4.52	3.94	3.52	2.93	3.07	3.02	3.70	4.18	4.01	3.99	44.60

RAINFALL AT LAWRENCE, MASS. Elevation, 51 feet.

(1885–1913, Essex Company.)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1856	2.15	2.13	1.03	3.78	6.24	2.73	2.40	18.12	6.53	4.30	4.33	4.96	58.70
1857	6.52	2.07	3.48	9.85	4.82	2.86	4.88	6.29	2.65	5.98	2.35	4.84	56.59
1858	2.79	1.80	2.47	3.09	3.39	4.90	3.99	4.86	4.05	3.30	1.70	5.02	41.36
1859	6.09	5.35	3.43	3.16	3.21	4.56	1.43	3.68	3.66	2.11	3.21	7.61	47.50
1860	1.12	2.58	1.06	0.76	2.02	3.77	5.51	3.71	6.74	2.13	2.81	2.60	34.81
1861	**5.08**	**2.71**	**4.62**	1.95	5.54	**1.89**	4.97	2.34	**2.07**	3.07	3.86	1.38	39.48
1862	5.43	2.20	3.85	**1.98**	**1.94**	3.31	4.61	2.74	2.40	**3.72**	5.36	1.20	38.74
1863	**3.98**	2.52	**4.82**	5.15	2.29	2.23	9.24	6.19	2.82	1.65	7.45	7.07	55.41
1864	2.55	0.98	6.99	6.43	2.27	1.38	1.34	3.70	1.73	3.86	3.88	3.96	39.07
1865	**3.80**	**3.51**	**4.26**	**2.02**	**6.01**	**2.20**	0.70	2.46	0.68	3.41	0.92	2.84	32.81
1866	0.75	4.43	3.70	0.85	4 65	2.71	4.67	2.41	4.76	1.79	4.13	3.16	38.01
1867	3.96	4.19	4.13	2.81	3.46	3.56	7.40	9.56	0.82	4.79	3.73	3.45	51.86
1868	3.06	1.46	**3.19**	5.08	9.22	2.67	1.41	4.45	13.42	1.66	6.69	0.68	52.99
1869	2.81	2.51	7.43	1.80	5.09	5.17	2.92	2.11	5.71	8.21	2.34	4.21	50.31
1870	6.98	5.36	5.72	7.44	1.49	3.49	1.55	3.64	**2.27**	4.35	3.62	3.03	48.94
1871	2.91	1.65	4.02	2.78	3.73	5.21	3.35	5.39	1.18	4.82	4.14	3.00	42.18
1872	1.18	0.25	2.94	2.47	3.76	5.88	5.47	8.31	4.59	3.30	1.39	3.93	43.47
1873	4.46	1.97	2.45	2.52	3.11	1.00	5.17	3.84	3.41	5.63	3.96	1.89	39.41
1874	3.29	2.81	1.37	6.43	4.51	3.34	4.61	9.21	1.36	1.50	1.82	2.67	42.92
1875	3.83	3.03	5.29	2.58	3.12	4.69	2.36	4.06	3.13	4.65	5.16	1.07	42.97
1876	2.01	4.15	7.11	3.52	4.87	2.14	5.67	0.30	4.22	3.02	4.71	2.24	43.96
1877	2.72	1.00	6.86	3.15	2.84	1.55	3.25	7.00	0.25	6.36	6.82	1.70	43.50
1878	5.27	4.78	3.38	6.19	0.39	3.92	2.59	4.81	1.61	4.84	5.50	4.77	48.05
1879	2.21	2.86	3.17	4.07	2.08	4.70	4.83	5.94	1.92	1.23	3.06	3.62	39.69
1880	4.89	3.21	3.23	2.23	1.77	3.38	5.56	2.51	1.45	2.49	1.98	2.68	35.38
1881	7.20	6.33	7.78	3 12	**4.03**	**4.87**	**2.81**	**1.84**	**3.01**	**2.10**	**4.36**	**4.01**	51.46
1882	**4.58**	**5.10**	**3.11**	**1.77**	**5.11**	**3.18**	**1.70**	**0.93**	**7.85**	**2.39**	**1.27**	**2.42**	39.41
1883	**3.16**	**3.63**	**2.03**	**2.29**	**4.92**	**2.47**	**4.06**	**1.21**	**1.67**	**5.58**	**1.86**	**3.21**	36.09
1884	**4.88**	**5.64**	**4.84**	**3.94**	**4.06**	**3.33**	**3.59**	**4.11**	**1.12**	**2.18**	**2.46**	**5.23**	45.38
1885	4.56	3.77	1.87	3.91	4.10	3.57	2.43	6.43	1.72	4.67	5.34	2.75	45.12
1886	6.03	6.19	3.03	1.59	3.66	1.95	3.58	2.80	4.06	2.40	4.91	4.02	44.22
1887	5.75	4.82	4.46	3.84	1.72	2.23	3.67	10.23	3.26	2.93	3.25	4.04	50.20
1888	4.45	4.04	4.94	3.44	4.24	2.49	2.82	4.24	7.74	5.92	6.16	4.77	55.25
1889	5.21	1.65	2.06	4.12	4.33	3.43	7.04	3.00	3.32	4.21	6.48	3.22	48.07
1890	2.58	3.50	6.51	1.80	5.54	3.71	2.62	5.03	4.13	8.68	1.63	4.96	50.69
1891	6.11	4.54	5.10	3.28	2.48	3.30	3.20	2.01	1.47	2.96	2.29	3.20	39.94
1892	4.45	2.18	2.74	0.60	5.83	3.87	1.24	3.47	2.37	1.45	5.74	1.04	34.98
1893	2.01	5.24	2.19	2.84	5.55	2.74	3.48	4.69	1.81	3.76	1.82	5.84	41.97
1894	3.00	3.10	1.14	2.02	4.00	0.54	4.01	0.83	2.80	3.79	2.73	3.15	31.11
1895	2.26	0.99	2.77	4.94	1.55	2.93	3.21	2.49	1.98	6.10	6.86	2.41	38.49
1896	1.61	4.57	6.57	1.09	2.43	1.77	3.32	2.86	6.92	2.65	2.81	1.74	38.34
1897	4.22	2.66	3.75	2.06	4.81	5.38	3.02	3.29	2.48	0.30	6.05	3.72	41.77
1898	4.71	4.92	1.41	4.93	3.52	2.68	2.74	7.56	2.67	7.08	4.63	2.58	49.43
1899	3.88	2.64	6.41	1.95	1.62	2.40	4.46	2.04	3.98	1.99	1.99	1.51	34.87
1900	5.10	8.17	5.53	1.79	3.90	2.52	2.08	3.54	3.39	2.73	4.42	2.41	45.58
1901	1.40	0.25	4.98	7.95	6.42	1.46	4.15	2.28	2.63	2.63	2.60	8.68	45.43
1902	2.24	3.06	6.66	5.39	2.41	2.50	5.09	4.77	3.77	4.29	0.78	5.92	46.88
1903	3.31	3.62	5.39	3.42	0.64	7.53	2.95	3.09	1.24	2.93	1.33	2.64	38.09
1904	3.91	2.66	2.63	7.22	2.55	3.79	3.18	2.88	5.60	1.09	1.35	1.97	38.83
1905	4.48	1.46	2.98	2.05	1.20	5.96	1.27	2.81	6 61	1.01	2.11	3.38	35.32

RAINFALL AT LAWRENCE, MASS. — *Continued.*

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1906	2.57	2.27	5.77	2.97	4.79	4.63	4.90	1.66	1.44	2.11	2.68	4.00	39.79
1907	2.37	1.77	1.97	2.80	2.10	2.26	4.64	0.66	5.56	4.10	5.46	3.56	37.25
1908	2.67	4.41	2.35	1.57	3.23	0.67	6.33	4.46	0.52	2.53	1.04	3.07	32.85
1909	4.03	4.77	3.53	4.23	1.93	1.45	2.62	1.80	4.01	1.02	3.46	3.68	36.53
1910	4.00	4.56	1.32	2.56	1.32	2.99	2.19	2.67	1.83	1.56	2.73	2.04	29.77
1911	2.52	2.80	3.64	1.89	0.30	1.52	3.19	5.56	2.10	2.93	3.68	3.60	33.73
1912	2.94	2.44	5.68	3.99	4.24	0.25	3.92	2.66	2.21	1.99	3.14	4.53	37.99
1913	2.34	3.03	4.87	3.22	4.21	2.18	1.09	2.44	2.41	6.89	2.13	3.38	38 19
Av.	3.70	3.28	3.96	3.39	3.53	3.10	3.63	4.10	3.29	3.47	3.53	3.45	42.43

RAINFALL AT LAWRENCE EXPERIMENT STATION. Elevation, 45 feet.
(State Board of Health.)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1904	4.50	1.21	2.95	8.86	2.65	3.89	3.23	3.19	6.71	1.63	1.85	2.35	43.02
1905	4.93	1.87	3.35	2.49	1.40	7.37	1.44	3.00	6.33	1.11	2.14	3.66	39.09
1906	2.58	2.54	6.14	2.98	5.62	5.58	4.70	1.85	1.58	2.33	3.56	4.31	43.77
1907	2.50	2 23	2.23	3.82	2.29	3.50	4.62	0.80	8.28	4.21	6.80	4.17	45.45
1908	3.42	5.14	2.58	2.02	3.56	0.83	6.36	4 95	0.56	3.53	1.19	3.10	37.24
1909	4.51	5.14	3.56	5.44	1.78	1.65	2.65	2.57	4.26	0.95	3.81	4.06	40.38
1910	4.57	5.96	0.87	2.60	1.66	4.54	2.08	3.24	2.10	2.14	3.82	2.00	35.58
1911	2.48	2.54	3.53	1.58	0.19	2.68	4.12	5.38	1.99	2.71	3.84	3.48	34.52
1912	2.73	2.46	5 60	3.88	3.85	0.22	3.56	2.31	2.17	1.97	2.98	4.57	36.30
1913	2.06	2.87	3.89	3.34	4.19	2.01	1.08	2.49	2.31	6.89	1.82	3.35	36.30
Av.	3.43	3.20	3.47	3.70	2.72	3.23	3.38	2.98	3.63	2.75	3.18	3.50	39.17

RAINFALL AT LEICESTER, MASS. Elevation, 800 feet.
(Lynde Brook Reservoir, Worcester Water Works.)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1875	2.85	3.62	3.10	2.36	2.44	3.77	4.92	8.04	3.78	5.78	4.79	1.09	46.54
1876	2.24	4.25	7.82	2.91	5.87	1.55	6.97	1.52	3.91	1.81	3.88	2.64	45.37
1877	1.79	0.37	7.03	1.99	1.90	2.14	3.84	4.04	0.48	8.42	7.07	1.26	40.33
1878	4.91	3.35	3.89	6.11	1.36	4.30	2.77	3.88	1.20	4.16	6.05	5.82	47.80
1879	1.34	3.40	3.22	3 67	1.64	3.06	3.88	5.29	1.72	0.95	2.37	3.95	34.49
1880	2.99	2.76	2.41	2.75	1.86	2.62	8.80	4 07	2.07	3.85	1.77	2.32	38.27
1881	3.61	4.71	5.46	1.67	4.43	4.58	2.88	2.04	2.50	3.20	3.77	4.46	43.31
1882	3.12	2.87	2.87	1.47	5.09	2.35	1.25	0.94	9.24	2.18	0.85	1.94	34.17
1883	2.24	3.61	1.46	1.60	4.85	2.90	2.99	1.12	1.57	4.97	1.51	1.76	30.58
1884	4.89	5.06	4.91	3.55	2.94	2.91	3.73	3.59	0.84	2.15	2.11	4.88	41.56
1885	3.66	3.19	0.74	2.60	2.82	2.37	2.73	6.95	1.60	5.11	5.86	3.09	40.72
1886	3.64	5.53	3.36	2.67	2.70	1.96	3.76	4.39	4.02	2.77	5 16	2.63	42 59
1887	3.68	4.28	4.28	2.66	1.20	2.65	7.30	6.83	1.32	2.78	2.87	3 48	43.33
1888	3.87	3.92	3.78	2.74	4.26	2.41	2.21	5.62	7.39	6.53	5.57	6.15	54 45
1889	4.99	1.73	1.35	3.32	2.82	2.28	8.28	3.44	3.41	4.82	6.31	2.63	45.38
1890	2.70	3.49	4.64	2.35	5.37	2.65	3.60	6.56	5.68	9.89	1.23	3.27	51.43
1891	6.98	4.18	4.89	2.40	1.88	2.73	3 47	5.36	2.12	2.86	2.13	4.52	43.82
1892	4.54	1.75	2.59	0.58	6.56	2.40	4.80	6.51	1.31	0.63	5.60	0.93	38 29
1893	2.71	4.67	4.23	3.64	6.52	2.68	1.28	3.53	2.07	4.65	2.09	4.45	42.52
1894	2.45	2.16	1.50	2.56	5.01	0.69	2.67	1.49	2.97	4.11	2.82	2.95	31 38
1895	3.64	0.47	2.58	4.54	2.37	3.81	6.00	5.67	2.51	7.43	7.85	2.96	49.83
1896	1.59	4 27	7 68	0.97	2.15	2.76	4 04	3 17	6.48	3.53	2 79	1 32	41 05

RAINFALL AT LEICESTER, MASS. — *Continued.*

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1897	4.42	2.29	3.60	3 04	4.22	4 05	6.42	3.51	1.49	0.62	6.20	5.84	45.70
1898	4.04	3.18	1.63	3.40	3 25	2.64	2.66	10.04	3 10	6.60	4.47	2.67	47.68
1899	4.21	2.78	6.23	1.81	1.06	1 81	3.69	2.91	4.06	1.46	2 64	1.85	37.51
1900	4.18	8.21	7.03	2.58	3.69	3.83	3.96	2.74	2.36	3.40	5.70	2.84	50.52
1901	1.72	0.88	6.12	9.26	6.54	0.96	4.26	4.02	3.20	4.14	2.21	9.12	52.43
1902	2.70	2.58	7.46	4.56	1.53	2.65	6.01	3.02	4.00	6.20	0.99	7 32	49.02
1903	3.43	4.46	6.70	3.11	0 84	10.48	4.67	4.56	2.06	3.57	2.42	4.09	50.39
1904	4.36	2.64	3.34	7 69	2.76	2 91	4.27	4.29	4.95	2.06	1.58	3.14	43.99
1905	5.63	2 08	3.88	2.00	1 04	5 80	3.03	2.76	6.69	1.74	2.39	3.82	40.86
1906	2.68	2.78	5.94	3.32	6 02	3.22	6.63	2.13	3.32	4.49	3.06	2.70	46.29
1907	4.26	1.78	1.74	3.29	2.99	3.62	2.68	1.06	10.56	5.08	6.29	5.02	48.37
1908	3.33	5.18	3.60	1.56	6.51	1.55	4.66	7.50	1.36	2.04	0 87	2.99	41.15
1909	3.23	6.27	4.27	6.04	2.48	2.26	1.25	3.24	3.69	1.27	2.27	3 82	40.09
1910	6.05	4.73	1.43	3.22	1.51	3.85	1.79	3.98	3.22	1.17	4.49	2 24	37.68
1911	2 65	2.80	3.72	2.64	1.54	2.51	2.63	5.15	4 10	5.48	4 18	2.94	40.34
1912	2.55	2 93	6.23	4.78	5.25	0.31	2.67	3.71	1.85	1.91	4.45	4 43	41.07
1913	3.13	3.31	5.66	4 90	4.34	1.18	1.75	2.56	5.41	6.57	3 07	3.50	45.38
Av.	3.51	3.40	4.16	3.24	3.38	2.98	3.98	4.14	3.43	3.86	3.63	3.51	43.22

RAINFALL AT LEOMINSTER, MASS. Elevation, 500 feet.

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1885	4.70	3.12	1.01	3.02	3.35	1.62	3.52	9.23	1.54	4.11	5.41	3.06	43.69
1886	4.99	5.35	2.97	2.38	3.68	1.70	4.26	3.53	4.95	2.89	5.43	3.59	45.72
1887	4.94	4.88	4.15	4.31	2.58	2.86	6.40	8.49	2.55	2.20	3.52	3.99	50.87
1888	3.95	4.41	5.41	3.68	3.92	4.31	2.67	4 94	10.57	6.05	5.92	5.38	61.21
1889	4.99	1.72	1.67	2 97	4 31	2.42	8.03	3.68	3.05	5.39	6.45	3.54	48.22
1890	2.98	3.91	6.10	2.22	5.43	2.66	4.62	6.05	6.34	8.83	1.56	3.48	54.18
1891	6.97	3.69	5.57	3.34	2.34	4.58	4.30	1.95	2.08	3.41	2.64	3.97	44.84
1892	4.91	2.52	3.10	0.63	6.15	4.55	2.93	6.56	1.76	0 89	5.30	0.87	40.17
1893	2.76	6 53	3.19	3.07	7.31	3.60	1.82	5.18	1.76	4.68	2.31	4.81	47.02
1894	2.37	2.84	1.15	2.98	3.82	0.91	2.34	0.60	3.99	4.24	3.45	2.73	31.42
1895	3.36	0.87	2.69	4.34	2.16	**3.46**	**6.60**	1.62	2.25	6.71	6.24	3.88	44.18
1896	1.63	5.89	6.16	1.21	2.16	2.49	3.28	2.70	7 18	3.27	2.95	1.59	40.51
1897	3.41	2.63	4.08	2.28	5.22	5.35	9.96	3.11	2.27	0.91	7.29	5.73	52.24
1898	5.63	3.90	1.26	4 42	3.74	2.69	3.03	9.30	4.83	7.25	5.90	3.02	54.97
1899	3.17	3.38	6.35	1.59	1.54	4.18	3.61	3.25	4.49	2.00	2.07	1.61	37.24
1900	4.27	9.03	6.38	2.26	4.13	2.85	2.74	3.53	3.88	3.44	6.11	3.03	51.65
1901	1.94	0.77	5.43	9.13	7.32	2.08	6.31	3.69	2.28	3.15	1.86	8.81	52.77
1902	1.96	4.08	5.13	4.39	2.84	1.95	3.28	4.34	3.76	6.54	0.65	4.90	43.82
1903	2.67	4.32	5.86	3.05	1.33	9.89	3.47	3.22	2.55	4.30	2.20	2.53	45.39
1904	3.80	2.01	3.32	8.05	3.43	3.27	2.41	4.11	5.50	1.51	1.27	2.54	41.22
1905	5.36	1.31	3.56	2.14	1.08	4.84	5.31	6.49	6.50	1.96	2.12	3.49	44.16
1906	2.39	**2.27**	4.42	2.69	6.38	4.67	5.61	3.19	1.64	3.64	2.30	4.63	43.83
1907	2.50	1.81	1.84	2.56	2.64	4.87	3.11	1.21	10.13	4.87	5.32	3.72	44.58
1908	3.16	4 66	2.61	1.67	6.37	1.68	2.70	6.61	0.96	2.28	1.02	3.06	36.78
1909	3.65	6.62	4.15	5.34	2.82	3.60	3.36	3.15	4.12	1.49	2 01	3.79	44.10
1910	5.72	4.76	1.29	3.08	1.84	5.31	1.65	4.09	2.95	1.35	3.77	1.94	37.75
1911	2.70	2.35	3.86	2.01	0.86	2.84	2.33	4.97	2.43	5.50	3.84	3.37	37.09
1912	2.43	2.38	5.67	3.96	5.12	0.27	3.44	2.96	3.01	2.77	4 00	3.79	39.80
1913	2.83	2.70	5.32	3 16	3.58	0.62	1.69	3.17	3.51	5.73	2 46	3.38	38.15
Av.	3.66	3.61	3.92	3.31	3.71	3.31	3.96	4.31	3.89	3.84	3.63	3.59	44.74

RAINFALL AT LINCOLN, MASS. Elevation, 250 feet.

(Lincoln Water Works.)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1906	2.17	1.33	4.10	2.23	3.78	3.04	3.75	3.34	2.23	1.60	2.38	3.56	33.51
1907	1.78	1.03	1.65	2.23	2.27	2.29	1.98	0.38	7.82	4.12	4.84	3.18	33.57
1908	2.75	4.43	2.55	2.43	3.67	1.37	1.75	4.17	0.00	0.85	0.34	2.39	26.70
1909	2.44	4.24	3.03	4.16	1.56	3.01	2.68	1.39	3.42	0.98	2.34	4.12	33.37
1910	4.60	3.52	1.22	2.23	1.01	3.53	1.20	3.47	1.82	0.44	3.48	1.92	28.44
1911	2.42	1.96	3.25	2.01	0.10	3.19	2.94	4.06	3.82	3.09	4.25	2.83	33.92
1912	2.05	2.35	5.66	3.27	5.16	0.20	2.84	2.43	1.86	2.82	3.78	4.32	36.74
1913	2.73	1.50	6.11	3.75	3.85	1.13	1.93	3.52	3.02	6.70	0.81	4.14	39.19
Av.	2.62	2.55	3.45	2.78	2.67	2.22	2.38	2.84	3.00	2.58	2.78	3.31	33.18

RAINFALL AT LINCOLN, MASS. Elevation, 187 feet.

(Baker's Bridge.)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1906	1.79	1.98	4.12	2.74	5.15	3.08	4.63	3.57	2.50	2.43	2.38	2.54	36.91
1907	3.36	1.12	1.33	2.35	3.10	2.84	2.01	1.22	8.99	3.97	5.54	3.32	39.15
1908	2.18	3.29	2.37	1.77	5.79	0.83	3.96	3.96	0.71	2.27	0.89	2.27	30.29
1909	5.05	3.78	3.03	4.47	1.77	3.70	3.12	3.08	4.77	1.16	2.95	2.76	39.64
1910	3.27	3.25	1.27	2.48	1.09	3.80	1.73	1.99	2.83	0.94	3.33	1.80	27.78
1911	2.31	1.88	2.95	1.85	1.15	3.90	3.71	4.20	4.03	3.32	4.14	3.83	37.27
1912	2.24	2.29	5.52	4.22	4.60	0.10	3.44	2.55	1.69	2.60	2.91	4.14	36.30
1913	2.46	3.48	4.95	4.11	4.02	1.13	2.77	3.12	3.50	5.00	2.44	2.66	39.64
Av.	2.83	2.63	3.19	3.00	3.34	2.42	3.17	2.96	3.63	2.71	3.07	2.92	35.87

RAINFALL AT LOWELL, MASS. Elevation, 100 feet.

(Proprietors Locks and Canals.)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1855	8.39	5.51	1.30	4.99	1.06	3.84	4.76	2.42	0.48	5.89	4.21	5.55	48.40
1856	3.51	1.26	1.37	3.49	5.89	2.18	1.86	12.42	4.78	2.52	2.53	4.16	45.97
1857	3.42	3.45	2.75	8.77	3.76	2.99	5.35	5.33	3.01	5.77	2.40	5.04	52.04
1858	2.58	1.78	1.52	4.21	3.53	5.40	3.24	3.42	3.58	3.10	1.26	4.11	37.73
1859	4.99	3.80	6.66	2.90	3.43	6.18	1.20	3.43	3.94	2.18	3.08	6.61	48.40
1860	0.80	2.44	2.14	1.09	1.85	4.84	6.55	4.30	9.96	2.50	3.71	6.49	46.67
1861	5.15	2.53	4.57	4.39	4.06	1.94	3.09	4.77	2.04	3.79	3.62	3.00	42.95
1862	6.02	2.68	5.20	2.22	1.90	5.77	5.20	2.55	2.18	3.52	5.08	2.29	44.61
1863	4.03	3.20	4.96	6.75	1.96	1.61	10.23	6.66	2.90	3.98	6.31	5.22	57.81
1864	2.64	0.98	8.42	3.59	2.81	1.07	1.82	3.54	2.90	3.84	4.10	4.94	40.65
1865	3.99	3.73	4.29	2.24	6.32	1.86	1.87	2.79	0.56	5.16	3.05	2.97	38.83
1866	1.92	4.70	3.60	2.85	4.48	2.66	5.56	3.68	3.81	1.64	2.71	3.74	41.35
1867	4.66	3.85	5.09	2.65	3.74	3.26	4.62	9.66	0.49	3.37	2.72	1.75	45.86
1868	3.51	1.20	3.35	5.57	9.03	4.45	0.86	2.84	11.63	0.97	4.70	1.45	49.56
1869	3.23	6.02	5.64	1.48	5.42	4.44	1.29	1.58	4.83	6.88	2.68	5.47	48.96
1870	7.09	4.86	5.79	6.48	2.05	4.44	1.98	3.40	1.52	5.08	2.89	3.13	48.71
1871	1.92	2.72	3.78	3.35	3.94	4.67	3.38	5.45	1.13	4.36	6.91	2.55	44.16

RAINFALL AT LOWELL, MASS. — *Continued.*

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1872	2.09	2.41	3.77	1.75	3.37	5.72	3.51	9.46	4.32	3.29	4.74	4.24	48.67
1873	5.21	3.38	3.90	2.97	3.72	0.37	3.78	4.01	4.31	4.52	5.01	3.87	45.05
1874	3.82	3.07	1.35	6.75	3.75	3.01	6.29	6.79	1.72	1.32	2.60	1.28	41.75
1875	3.02	3.22	4.87	3.48	3.26	4.59	2.63	4.65	3.33	5.14	4.41	1.03	43.63
1876	2.11	4.59	8.12	4.78	3.13	2.79	7.11	0.27	4.18	1.84	4.22	4.32	47.46
1877	2.95	0.89	6.45	4.03	3.08	2.34	2.81	4.76	0.25	6.27	6.79	0.75	41.37
1878	5.28	5.31	4.35	8.14	0.59	3.05	2.19	10.77	0.89	5.38	6.71	5.92	58.58
1879	2.48	3.76	5.01	4.03	2.28	5.71	4.38	6.18	2.17	1.43	3.36	4.46	45.25
1880	4.36	3.94	3.00	2.38	2.68	1.70	6.52	3.16	1.54	2.82	1.84	2.58	36.52
1881	5.34	3.15	7.21	1.86	4.27	4.90	2.50	1.73	2.73	1.96	4.28	4.25	44.18
1882	4.53	5.77	3.02	1.67	4.90	2.79	1.68	0.98	7.31	2.31	1.01	2.03	38.00
1883	2.93	3.40	1.88	1.90	4.64	2.04	3.58	0.91	1.49	5.29	1.73	2.62	32.41
1884	4.94	5.70	5.01	4.11	3.68	3.06	3.20	3.98	0.92	1.94	2.33	5.15	44.02
1885	4.86	4.10	1.02	3.61	3.59	4.29	6.03	6.10	1.58	4.84	5.18	2.81	48.01
1886	6.76	6.54	3.39	1.97	3.59	1.86	3.51	3.13	3.96	2.78	4.90	4.45	46.84
1887	5.72	5.18	4.74	4.05	1.64	2.61	5.42	10.93	2.23	3.12	3.27	4.55	53.46
1888	4.66	4.31	6.52	3.78	3.89	2.81	3.06	4.86	7.97	6.78	5.98	5.31	59.93
1889	5.04	1.71	1.99	3.63	3.89	2.59	6.10	3.98	3.27	4.27	6.93	3.37	46.77
1890	2.77	3.77	6.83	1.99	5.67	3.53	3.45	4.87	4.46	7.71	1.58	4.47	51.10
1891	7.04	4.84	6.00	3.56	2.29	3.66	3.17	2.14	1.79	2.93	1.92	3.20	42.54
1892	5.39	2.74	3.24	0.63	5.86	4.44	2.32	4.30	1.97	1.38	5.83	1.11	39.21
1893	2.39	7.71	2.44	2.95	6.66	2.41	2.76	3.94	2.29	3.82	1.93	5.46	44.76
1894	3.35	3.50	1.27	3.76	4.36	0.37	3.00	0.92	3.03	3.46	3.52	3.84	34.38
1895	3.30	1.47	2.66	4.57	1.68	2.63	2.66	2.02	2.23	6.67	8.16	2.68	40.73
1896	2.24	4.95	6.53	1.34	2.32	2.68	3.79	2.76	9.69	3.00	3.02	2.13	44.45
1897	4.35	2.96	4.15	2.25	4.94	6.11	4.62	5.63	3.04	0.59	6.49	5.32	50.45
1898	4.52	7.05	1.65	5.20	3.04	3.65	2.93	8.23	1.97	6.85	6.45	2.74	54.28
1899	4.37	5.02	7.95	1.50	2.10	2.71	4.12	2.11	3.66	1.99	2.71	1.68	39.92
1900	5.45	10.12	6.57	2.16	3.78	2.71	2.65	3.73	4.20	3.33	6.18	3.01	53.89
1901	1.72	1.06	5.76	10.57	7.68	1.49	4.78	3.27	3.28	3.43	2.79	8.55	54.38
1902	2.27	6.16	5.28	5.47	2.37	2.11	3.56	5.16	6.29	5.29	0.86	6.29	51.11
1903	3.39	3.96	5.90	3.69	0.82	9.18	2.62	3.68	1.74	4.46	1.53	3.01	43.98
1904	4.54	2.48	2.65	9.32	2.98	4.00	1.83	3.21	5.51	1.28	1.51	2.33	41.64
1905	6.96	1.70	3.71	2.15	1.29	5.18	0.59	4.50	6.39	1.33	2.25	3.86	39.91
1906	2.43	2.59	5.97	3.00	6.00	4.80	5.95	3.47	1.43	2.38	3.08	4.22	45.32
1907	2.77	2.39	2.15	3.64	2.58	3.03	4.37	1.36	8.52	4.49	5.77	4.43	45.50
1908	3.20	4.96	2.71	1.95	4.18	0.93	3.04	4.29	0.34	2.57	1.14	3.03	32.34
1909	4.17	5.79	3.51	5.53	3.11	2.13	2.52	2.46	4.21	1.20	2.65	4.08	41.36
1910	4.41	5.87	0.74	2.57	1.31	4.37	1.93	3.21	2.04	1.18	3.47	2.15	33.25
1911	2.66	2.88	3.51	1.99	0.81	2.47	3.35	5.75	2.59	3.42	3.57	3.53	36.53
1912	2.90	2.63	5.51	3.92	5.09	0.28	5.51	2.23	2.33	2.23	3.09	4.37	40.09
1913	2.72	2.80	5.00	3.01	3.49	2.13	1.21	2.87	3.72	6.77	2.18	3.59	39.49
Av.	3.95	3.81	4.20	3.71	3.55	3.30	3.62	4.25	3.40	3.59	3.71	3.74	44.83

RAINFALL AT LOWELL, MASS. Elevation, 80 feet.

(Merrimack Manufacturing Co.)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1826	1.56	1.00	3.75	1.27	1.80	3.51	1.77	7.00	3.13	2.80	2.34	2.57	32.50
1827	1.63	2.56	3.27	5.11	5.14	3.86	3.72	3.39	7.09	6.07	6.21	3.81	51.86
1828	2.16	2.94	1.48	2.32	7.19	3.15	4.73	1.06	3.70	2.51	6.11	0.33	37.68
1829	4.52	3.68	3.83	4.34	3.25	1.53	2.48	2.16	2.02	0.87	5.81	2.45	36.94
1830	2.45	0.61	3.33	1.95	2.52	4.46	5.72	3.60	3.81	2.26	5.92	5.96	42.59
1831	3.19	4.56	3.93	8.16	3.99	3.41	3.72	4.38	5.89	4.29	3.78	2.43	51.73
1832	4.84	2.85	3.78	4.18	6.96	1.15	4.61	9.90	2.29	3.84	4.31	4.19	52.90
1833	2.00	1.30	3.54	3.34	2.96	4.49	5.23	2.37	3.09	7.00	3.80	4.76	43.88
1834	1.34	1.15	1.03	2.13	5.91	3.99	4.85	0.95	1.95	4.20	2.16	2.12	31.78
1835	4.89	1.09	2.29	4.11	2.59	1.93	4.89	2.36	1.56	3.58	1.15	1.98	32.42
1836	2.31	0.93	0.72	1.89	1.61	2.89	8.60	1.71	1.40	2.98	5.12	5.38	35.54
1837	0.34	1.81	2.26	4.02	7.27	5.12	1.49	2.41	0.93	1.55	1.57	2.09	30.86
1838	2.63	0.00	2.88	2.72	3.41	3.88	2.03	3.50	6.35	4.78	4.46	0.88	37.52
1839	1.24	2.31	1.16	5.67	3.28	4.30	1.24	4.92	1.91	2.17	2.26	4.76	38.22
1840	0.92	2.15	4.15	4.63	1.95	1.82	1.68	6.89	2.72	3.70	7.21	0.88	38.70
1841	4.10	2.00	1.76	7.13	2.70	2.39	1.46	3.93	4.06	3.10	3.28	4.47	40.38
1842	0.97	3.99	2.89	2.87	2.38	5.19	1.03	5.43	4.31	1.36	4.95	3.24	38.61
1843	2.14	2.04	5.44	3.14	2.10	4.49	2.39	8.16	1.36	3.68	3.28	1.25	39.47
1844	0.93	1.07	3.45	0.29	3.61	1.87	3.50	6.90	3.55	5.18	2.25	3.08	35.71
1845	1.20	1.80	3.64	1.68	2.75	2.68	3.40	2.58	3.05	3.36	7.97	4.89	39.00
1846	2.44	1.82	3.27	1.31	4.21	2.40	3.59	2.79	0.64	1.61	2.70	1.25	28.03
1847	5.42	3.14	3.46	2.26	2.15	6.75	3.01	3.81	4.85	3.01	3.70	4.70	46.26
1848	2.83	2.10	3.54	1.60	7.41	4.01	2.16	3.15	4.06	5.00	2.68	3.75	42.29
1849	1.13	0.83	5.07	2.06	4.04	1.70	2.20	5.53	2.51	7.34	5.70	3.80	41.91
1850	3.32	4.38	2.75	4.22	7.12	2.23	2.78	7.65	6.21	2.61	2.92	4.90	51.09
1851	2.07	4.43	1.76	7.88	3.29	2.00	4.26	3.29	2.86	6.51	5.30	2.03	45.68
1852	1.44	2.96	3.06	8.86	1.22	3.33	2.31	8.07	1.64	2.14	4.78	2.97	42.78
1853	1.52	6.06	2.05	3.45	5.40	0.60	2.36	8.37	4.32	4.30	3.79	1.70	43.92
1854	2.36	3.53	3.34	4.68	4.31	3.49	2.12	0.18	4.67	4.28	6.28	2.84	42.08
1855	7.81	4.48	1.12	5.04	1.07	3.81	3.99	2.32	0.63	5.78	3.90	4.94	44.89
1856	2.83	1.07	0.90	3.48	5.31	2.09	1.73	12.31	4.79	2.03	2.53	3.42	42.49
1857	3.86	1.63	2.58	8.02	3.58	3.16	5.67	5.68	2.29	5.52	2.26	5.13	49.38
1858	1.88	1.49	1.47	4.11	3.32	5.07	3.42	3.18	3.10	3.13	2.01	3.62	35.80
1859	5.62	2.86	6.24	2.76	3.80	5.83	1.58	3.98	3.80	2.32	3.25	5.47	47.51
1860	0.66	2.06	2.08	1.02	1.91	4.87	6.87	5.03	9.44	2.46	4.65	5.86	46.91
1861	5.01	2.89	4.67	4.52	4.07	1.84	2.98	5.12	2.11	3.67	4.57	1.87	43.32
1862	6.86	3.27	4.85	1.75	1.99	6.04	5.20	2.29	1.87	3.92	4.60	1.62	44.26
1863	3.93	2.91	4.69	4.37	1.91	1.59	9.77	6.07	3.07	3.66	6.02	4.38	52.37
1864	2.44	0.89	8.03	2.56	2.56	1.25	1.62	3.22	2.91	3.79	3.93	4.91	38.11
1865	3.61	3.29	4.24	1.80	5.71	2.54	2.39	2.42	0.56	5.86	2.08	2.88	37.38
1866	1.66	4.68	3.50	2.56	4.22	2.64	4.54	3.52	3.92	1.62	2.32	3.00	38.18
1867	4.34	3.32	4.38	2.60	4.53	3.95	4.28	10.30	0.62	3.32	2.48	1.42	45.54
1868	3.54	1.88	3.04	5.06	7.64	3.62	1.18	4.00	10.96	0.80	4.78	1.46	47.96
1869	2.30	5.62	6.26	1.38	4.92	4.28	1.52	1.60	5.32	6.80	2.80	4.50	47.30
1870	6.41	4.36	4.49	5.94	1.96	6.17	1.41	3.07	3.02	3.64	2.92	2.91	46.30
1871	1.80	2.42	3.93	3.06	3.68	4.50	3.25	6.65	1.22	4.48	7.00	2.46	44.45
1872	1.66	1.86	3.16	1.52	3.42	5.50	3.40	8.38	4.36	3.30	4.58	3.18	44.32
1873	3.60	4.44	3.20	2.42	3.20	0.38	3.82	3.72	3.86	4.64	3.56	3.02	39.86
1874	2.86	2.24	1.98	4.94	3.36	2.96	5.72	5.84	0.88	1.50	2.38	1.02	35.68
1875	2.68	3.43	4.01	2.83	2.72	4.30	2.70	4.26	3.30	5.12	3.96	0.98	40.29

RAINFALL AT LOWELL, MASS. — *Continued.*

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1876	1.54	4.28	7.85	4.92	2.98	2.40	6.72	0.27	4.14	2.22	4.19	3.92	45.43
1877	2.32	0.64	6.32	4.60	3.24	2.18	3.11	3.64	0.14	7.54	6.20	0.96	40.89
1878	4.62	5.03	3.80	8.88	0.30	3.14	2.16	10.78	0.78	5.01	6.09	6.04	56.63
1879	2.30	3.80	5.18	3.86	1.84	5.72	4.13	5.62	2.28	1.35	3.20	4.42	43.70
1880	4.12	3.18	3.08	2.28	2.54	1.82	6.52	3.00	1.60	2.62	1.88	2.64	35.28
1881	4.20	4.32	5.30	1.90	3.80	4.84	3.12	1.96	3.29	2.24	4.44	3.78	43.19
1882	4.64	4.44	3.20	1.88	5.33	3.58	1.72	0.88	8.40	2.48	1.54	2.82	40.91
1883	3.40	3.86	2.18	2.68	5.21	2.91	4.54	1.52	1.86	5.88	2.00	3.80	39.84
1884	4.82	5.58	4.68	3.78	4.44	3.60	3.98	4.24	1.32	2.42	2.60	5.32	46.78
1885	4.64	4.10	1.26	3.60	3.84	4.00	6.46	6.60	1.80	4.48	4.84	3.10	48.72
1886	5.88	6.26	3.26	1.56	3.26	2.46	3.79	3.02	3.92	2.64	5.10	4.94	46.09
1887	5.54	5.18	4.73	3.16	0.86	1.18	5.16	12.28	2.56	3.08	3.52	4.88	52.13
1888	5.16	4.55	3.98	4.04	4.10	3.00	3.64	5.22	7.72	7.14	5.62	5.32	59.49
1889	4.74	1.72	1.95	2.16	3.14	2.36	6.22	3.18	3.20	4.42	6.28	2.06	41.43
1890	2.20	4.18	6.65	2.36	5.20	3.70	3.36	4.95	4.28	6.68	1.46	3.96	48.98
1891	6.62	2.63	4.20	2.80	1.96	3.20	2.62	1.88	1.30	2.60	0.93	3.09	33.83
1892	5.42	2.22	2.91	0.39	5.15	4.73	1.95	3.61	2.17	0.84	5.65	0.63	35.67
1893	2.50	7.07	2.14	2.70	5.29	2.57	2.65	3.46	2.60	4.24	2.07	5.80	43.09
1894	3.47	2.84	1.38	3.14	4.24	0.52	3.72	1.14	3.59	3.56	2.60	3.34	33.54
1895	2.83	0.78	2.58	3.98	1.28	3.12	2.93	1.99	2.16	7.87	5.81	2.76	38.09
1896	1.52	4.19	6.53	0.92	2.11	2.52	3.56	3.04	9.25	3.00	2.92	1.69	41.25
1897	3.63	2.69	2.58	1.06	2.67	6.66	4.54	3.92	2.97	0.50	5.77	4.65	41.64
1898	4.41	7.13	1.65	5.23	3.01	4.23	2.77	7.95	2.02	6.18	5.77	3.40	53.75
1899	2.66	4.50	5.98	1.76	1.92	2.82	4.06	2.26	4.01	2.16	2.46	1.80	36.39
1900	5.80	9.91	6.30	2.34	3.78	2.78	2.26	3.11	4.46	3.12	5.88	2.28	52.02
1901	1.73	1.06	5.78	10.23	6.95	1.56	4.76	3.63	3.54	3.33	2.67	8.63	53.87
1902	2.28	6.05	5.37	4.80	2.99	2.21	3.64	5.14	6.15	5.88	0.60	6.26	51.37
1903	3.27	3.95	5.83	3.52	0.98	8.97	2.75	3.13	1.51	4.20	1.55	2.91	42.57
1904	3.88	2.46	2.72	8.65	2.40	4.13	2.06	3.52	5.39	1.05	1.42	2.21	39.89
1905	5.39	1.28	3.11	2.26	1.17	5.21	1.19	3.54	6.73	1.40	2.30	3.78	37.36
1906	2.53	1.98	4.54	3.18	6.06	5.26	5.19	3.28	1.39	2.12	2.43	3.83	41.79
1907	2.37	1.73	1.86	2.29	2.31	2.37	4.47	1.25	7.40	4.35	4.94	3.28	38.62
1908	2.15	5.85	2.45	1.78	3.28	0.90	3.24	5.00	0.31	2.27	1.04	2.92	31.19
1909	3.37	4.91	3.11	4.28	1.89	1.62	2.36	1.93	3.91	1.12	2.44	3.86	34.80
1910	3.51	3.75	1.45	2.72	1.36	2.98	2.18	3.24	1.83	1.11	2.63	1.72	28.51
1911	2.82	2.34	3.49	1.64	0.71	1.90	3.25	5.49	2.57	3.13	3.59	3.30	34.23
1912	2.48	1.56	4.27	2.93	4.74	0.42	5.67	2.23	2.15	2.02	2.67	4.50	35.64
1913	2.21	2.73	4.18	2.99	3.25	1.92	1.06	2.73	3.43	5.78	2.26	3.19	35.73
Av.	3.18	3.12	3.56	3.48	3.49	3.28	3.53	4.24	3.37	3.59	3.72	3.36	41.92

RAINFALL AT LUDLOW, MASS. Elevation, 410 feet.

(Ludlow Reservoir, Springfield Water Works.)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1876	2.03	4.97	6.16	2.52	2.64	2.13	4.88	1.24	3.03	0.53	2.75	0.34	33.22
1877	2.52	0.36	5.84	2.44	0.92	3.07	7.04	2.22	0.54	7.74	4.17	1.28	38.14
1878	3.33	2.59	3.64	5.37	1.60	5.94	2.71	2.47	2.26	2.83	5.00	4.86	42.60
1879	1.95	3.65	4.42	3.53	3.12	5.66	3.45	6.36	3.15	1.27	2.49	4.43	43.48
1880	3.85	2.27	2.66	2.93	2.05	1.82	6.44	3.36	1.80	3.00	1.78	1.70	33.66

RAINFALL AT LUDLOW, MASS.—*Continued.*

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1881	4.02	3.97	3.99	1.68	4.64	3.89	3.79	3.45	1.17	3.11	3.86	5.22	42.79
1882	4.44	3.08	2.54	1.37	5.22	4.71	1.26	1.40	9.88	2.12	1.45	2.28	39.75
1883	2.43	3.88	1.61	2.03	4.25	4.39	3.62	1.67	2.76	5.28	1.20	2.26	35.38
1884	3.58	4.49	4.76	1.71	2.54	2.92	5.77	6.28	1.29	2.56	3.55	4.91	44.36
1885	3.92	2.84	1.11	2.74	2.30	2.18	2.22	8.38	0.96	3.64	4.94	4.37	39.60
1886	4.52	4.77	3.72	1.98	4.38	1.70	5.19	2.89	4.69	3.44	5.03	3.20	45.51
1887	5.62	4.85	4.92	2.76	0.85	5.38	5.67	7.30	1.45	2.05	3.44	4.31	48.60
1888	3.49	4.65	7.65	3.11	4.76	3.88	2.85	4.16	9.34	5.65	5.08	4.60	59.22
1889	3.97	1.97	2.09	2.73	3.57	4.37	9.05	2.38	4.04	5.08	5.85	3.79	48.89
1890	3.17	4.52	6.21	2.23	5.56	2.87	5.65	5.91	7.03	6.22	1.51	3.41	54.29
1891	7.87	4.70	2.99	2.87	1.73	3.83	5.84	3.32	1.77	3.73	3.00	4.85	46.50
1892	6.60	2.15	2.85	0.85	6.73	3.67	5.92	6.22	1.80	0.80	5.82	2.15	45.56
1893	3.40	6.50	3.75	3.80	5.26	3.73	1.77	3.10	2.42	4.16	1.62	4.56	44.07
1894	2.32	2.37	1.12	2.00	3.29	2.01	2.03	0.84	3.42	3.98	4.07	2.11	29.56
1895	2.10	1.06	2.41	6.17	2.05	2.85	6.35	2.90	3.75	6.65	5.06	3.83	45.18
1896	0.92	3.74	5.23	1.40	2.60	2.45	5.73	1.32	5.27	3.68	2.35	1.41	36.10
1897	2.77	2.25	3.27	2.75	4.74	5.21	13.12	4.32	1.86	0.93	6.49	5.77	53.48
1898	6.12	2.95	2.22	4.21	4.65	3.05	4.67	8.30	3.20	7.04	5.95	3.25	55.61
1899	2.80	4.65	6.52	2.40	0.65	4.10	5.05	1.49	4.24	2.97	1.92	1.96	38.75
1900	3.84	7.62	5.75	1.66	4.41	4.50	4.49	3.16	3.18	4.33	5.88	2.71	51.53
1901	1.79	0.69	6.00	5.93	5.32	1.23	3.37	7.64	3.28	4.84	1.57	8.35	50.01
1902	1.78	2.70	4.30	3.71	1.72	3.23	3.81	4.50	4.91	5.30	1.39	6.50	43.85
1903	2.64	3.75	5.98	2.73	1.06	8.03	5.12	5.79	2.56	2.33	2.86	2.29	45.14
1904	3.04	2.65	3.68	5.53	2.75	4.70	2.90	5.15	6.29	1.39	1.25	2.33	41.66
1905	4.03	1.06	3.33	2.70	1.05	3.55	2.56	5.24	6.29	1.48	1.95	3.15	36.39
1906	2.58	2.01	5.20	2.91	5.22	3.57	7.68	3.43	3.72	6.14	1.38	4.00	47.84
1907	2.61	2.03	1.60	2.68	3.71	2.68	3.62	1.32	8.43	5.89	3.81	3.28	41.66
1908	2.43	2.57	5.27	2.29	3.65	1.78	4.42	6.07	0.96	1.19	1.04	2.41	34.08
1909	2.47	4.60	2.65	5.75	2.14	1.69	3.41	2.20	5.15	1.37	0.92	2.09	34.44
1910	5.08	0.97	1.31	7.59	5.00	2.77	1.48	2.69	3.17	1.15	3.82	2.02	37.05
1911	2.62	1.91	3.47	2.04	1.52	1.25	4.49	7.33	3.68	6.97	3.35	3.44	42.07
1912	1.55	1.46	5.75	4.68	5.51	0.49	2.43	3.15	1.62	1.47	3.71	3.85	35.67
1913	3.56	2.42	5.92	3.61	4.26	0.98	1.33	3.84	2.62	6.00	2.42	2.37	39.33
Av.	3.36	3.15	4.00	3.14	3.35	3.32	4.50	4.02	3.61	3.64	3.26	3.41	42.76

RAINFALL AT LYNN, MASS. Elevation, 40 feet.

(Water Works Pumping Station.)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1873	4.71	2.42	3.45	1.94	2.95	0.76	2.57	4.12	3.95	4.28	4.74	3.57	39.46
1874	2.04	3.60	1.46	6.62	3.62	2.83	2.91	4.89	1.68	1.02	2.55	1.70	34.92
1875	3.32	2.78	4.33	3.54	3.44	5.57	2.04	3.13	4.28	4.46	3.98	0.99	41.86
1876	1.83	4.72	6.04	3.37	3.21	1.07	7.36	0.55	3.67	1.67	7.92	3.64	45.05
1877	3.22	0.84	8.28	3.85	1.94	2.39	3.17	3.79	0.66	9.20	7.56	0.75	45.65
1878	6.25	4.81	7.31	6.20	0.98	2.35	3.61	8.45	1.98	4.96	6.19	4.27	57.36
1879	2.80	2.57	4.46	5.66	0.97	5.70	2.83	6.46	1.94	0.77	2.90	3.98	41.04
1880	2.84	3.43	3.25	2.46	3.16	1.33	7.24	3.46	1.86	2.65	2.44	3.16	37.28
1881	5.42	4.70	7.31	1.86	3.50	7.11	3.35	0.88	3.00	1.93	3.84	3.41	46.31
1882	5.30	4.05	2.45	2.01	5.12	1.14	1.79	0.69	8.51	2.03	1.46	1.84	36.39

RAINFALL AT LYNN, MASS. —*Continued.*

(Water Works Pumping Station.)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1883	2.02	2.38	1.46	2.69	2.73	2.03	2.94	0.96	1.10	5.82	1.99	2.02	28.14
1884	4.19	6.97	5.20	5.15	3.68	3.31	2.88	4.58	1.33	2.78	2.90	4.78	47.75
1885	5.41	2.60	1.30	3.53	4.01	3.37	1.62	7.71	1.42	6.20	5.60	2.24	45.01
1886	5.98	7.47	3.70	1.90	3.30	1.57	4.05	3.59	3.22	3.77	3.96	5.75	48.26
1887	6.20	4.98	5.50	5.24	1.69	2.24	5.89	5.84	1.22	2.92	3.09	4.05	48.86
1888	3.87	3.02	5.88	2.72	5.87	2.09	2.54	6.80	8.83	5.40	8.13	5.46	60.61
1889	6.43	2.36	3.19	3 56	4.51	4.74	8.75	5.03	3.43	5.03	6.65	2.97	56.65
1890	2.51	4.69	7.56	2.59	5.99	3.17	1.99	4.62	5.68	7.36	1.34	5.39	52.89
1891	6.42	5.12	4.51	2.40	2.29	3.83	3.38	2.91	2.43	5.95	2.31	3.41	44.96
1892	4.86	2.43	3.33	0 65	5.53	3.56	1.62	6.95	1.65	2.52	5.26	1.31	39.67
1893	2.15	6.40	2.17	3.41	5.64	3.05	1.82	8.68	1.43	3.21	1.79	5.51	45.26
1894	2.84	2.74	1.11	3.33	4.91	0.59	2.98	2.56	2.18	5.79	3.34	4.25	36.62
1895	3.72	1.11	3.05	3.35	3.21	3.23	3.15	4.55	1.27	10.12	5.64	2.39	44.79
1896	2.78	5.75	4.97	1.56	2.03	2.17	2.53	2.21	6.08	3.33	3.87	1.22	38. 0
1897	2.37	1.88	2.39	2.49	3.98	4.70	3.25	4.25	2.14	0.32	6.05	4.23	38.05
1898	5.87	3.91	2.01	6.15	4.22	1.53	4.71	8.25	2.41	7.19	5.09	2.86	54.20
1899	3.73	3.28	6.38	1.42	1.57	2.62	2.21	1.35	5.18	2.53	1.99	1.64	33.90
1900	3.95	5.84	3.38	1.64	5.21	1.26	1.95	1.62	3.79	3.13	4.31	2.21	38.29
1901	1.97	1.00	5.84	8.86	7.11	1.73	4.62	3.48	3.20	2.82	2.61	8.16	51.40
1902	2.00	6.95	4.41	4.23	0.97	2.27	3.02	2.71	3.03	4.81	1.47	5.59	41.46
1903	3.83	4.37	6.18	4.52	0.37	8.56	2.76	2.65	1.61	4.08	1.41	2.34	42.68
1904	3.54	2.65	3.36	7.67	4.70	2.97	1.43	2.67	5.87	2.44	1.81	2.39	41.50
1905	4.51	1.18	2.59	2.55	1.61	5.33	1.12	2.70	6.20	1.13	2.09	3.70	34.71
1906	2.58	2.65	6.60	1.92	4.26	4.13	3.58	1.98	1.89	3.05	2.65	4.23	39.52
1907	2.56	2.05	1.91	3.21	2.49	2.14	2.05	1.14	8.06	2.21	5.00	3.58	36.40
1908	2.11	2.57	2.65	1.55	2.92	0.94	3.37	3.67	0.50	3.97	0.90	2.02	27.17
1909	4.42	3.70	2.60	3.30	1.47	3.36	2.39	2 96	3.84	1.29	3.92	2.88	36.13
1910	3.99	3.88	0 93	1.65	1.24	3.67	1.46	0.92	2 06	0.98	2.27	1.96	25.01
1911	2.29	3.00	2.51	1.74	0.43	2.82	5.01	3.76	2.69	1.89	3.26	2.91	32.31
1912	2.78	1.80	4.04	2.54	5.02	0.28	4.04	1.72	2.83	1.32	2.54	4.78	33.69
1913	2.85	2.47	4.27	4.81	3.16	1.51	3.23	3.42	2.57	6.39	2.32	3.22	40.22
Av.	3.72	3.54	3.98	3.41	3.29	2.90	3.25	3.72	3.19	3.73	3.64	3.34	41.71

RAINFALL AT LYNN, MASS. Elevation, 70 feet.

(City Hall.)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1877	...	...	...	...	...	...	...	...	0.75	10.45	9.08	0.99	...
1878	6.48	5.61	7.59	6.90	0.71	2.40	3.69	7.08	2.33	5.56	5.26	3.85	57.46
1879	1.87	3.25	3.94	6.35	1.11	6.57	3.13	9.32	1 82	0.72	3 79	4.71	46.58
1880	3.47	2.92	2.84	2.21	2.67	0.95	5.78	3.19	1.53	2.33	2.82	2.34	33.05
1881	5.60	4.75	8.42	1.30	3.14	6.22	3.13	0.61	2.43	1.87	3.59	2.97	44.03
1882	4.76	3.54	2.35	1 77	4.72	0.93	1.76	0.83	7.51	1.77	1.16	1 84	32.94
1883	...	...	...	...	...	...	...	...	...	...	...	...	...
1884	...	...	...	...	...	...	...	...	...	...	...	...	...
1885	4.85	2.15	1.03	3.22	3.57	3.28	1.50	7 16	1 42	5.85	5.20	1.85	41.08
1886	4.89	6 69	3 05	1 82	3 41	1 44	3 48	3 44	3 07	3 33	3 33	4 51	42 46

RAINFALL AT LYNN, MASS. — *Continued.*

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1887	6.20	4.98	5.50	5.24	1.69	2.24	5.89	5.84	1.22	2.92	3.09	4.05	48.86
1888	3.09	2.20	4.41	2.81	5.30	2.06	2.32	5.93	8.04	4.51	6.52	5.46	52.65
1889	4.98	1.81	2.32	3.14	3.72	4.64	7.60	3.99	2.95	3.94	5.75	2.35	47.19
1890	1.82	3.05	5.62	2.19	5.43	2.80	2.17	2.89	4.80	6.75	1.48	4.55	43.55
1891	6.02	4.15	3.61	2.13	1.98	4.00	3.25	3.25	2.77	5.13	2.22	3.39	41.90
1892	4.02	2.13	1.93	0.68	5.23	3.22	1.44	6.50	1.63	2.56	4.67	1.12	35.13
1893	1.43	4.93	2.03	2.72	5.42	3.43	1.73	9.54	1.47	3.42	1.59	4.71	42.42
1894	2.21	1.99	0.86	2.68	4.43	0.50	2.34	1.95	1.88	5.00	2.70	3.28	29.82
1895	3.13	0.76	2.60	3.16	3.54	2.31	3.18	5.18	1.07	9.72	5.34	1.69	41.68
1896	2.02	4.41	3.91	1.57	2.16	2.29	2.43	2.21	5.53	3.31	3.54	1.06	34.47
1897	2.02	1.23	2.20	2.92	4.25	4.54	3.10	5.06	2.18	0.29	6.24	3.73	37.76
1898	4.25	3.67	1.64	6.11	4.13	1.45	5.07	7.53	2.15	7.25	4.69	2.42	50.36
1899	...	...	...	...	...	...	...	...	...	...	...	...	...
1900	3.64	5.42	3.64	1.27	5.21	1.36	2.03	1.97	1.15	3.22	3.69	1.85	34.45
1901	1.49	0.63	5.71	8.23	6.71	1.94	4.48	3.26	2.87	2.74	2.75	6.74	47.55
1902	1.32	5.50	3.42	4.09	0.84	1.91	2.79	2.08	2.35	4.55	1.39	3.54	33.78
1903	3.16	2.49	5.19	3.95	0.32	8.18	2.30	2.36	1.51	3.51	1.21	1.89	36.07
1904	3.08	2.09	2.07	8.36	4.23	2.77	1.12	2.11	5.03	1.74	1.77	1.89	36.26
1905	2.44	1.31	2.17	2.44	1.21	5.03	0.76	2.04	4.14	0.50	2.04	3.05	27.13
1906	1.81	2.30	4.66	2.37	4.26	4.02	3.85	1.92	2.08	3.12	2.58	4.04	3′.01
1907	1.75	1.23	1.94	2.12	2.81	2.79	1.22	1.01	7.96	2.42	6.05	3.69	34.99
1908	2.03	3.77	3.09	2.23	3.23	0.71	3.89	3.76	0.62	4.14	0.89	2.15	30.51
1909	3.55	4.39	3.58	3.90	1.53	4.00	2.31	3.07	4.63	1.20	4.25	3.11	39.52
1910	3.62	4.04	0.85	1.97	1.12	4.52	1.20	0.61	2.38	1.02	3.27	1.59	26.19
1911	2.33	2.34	2.93	2.31	0.65	4.02	5.20	4.83	3.29	2.47	3.72	3.17	37.26
1912	2.74	2.38	4.53	2.98	4.71	0.44	4.12	1.72	2.72	1.47	2.42	4.34	34.57
1913	2.30	2.86	4.10	4.61	3.31	1.52	3.05	3.17	2.52	5.81	1.98	3.42	38.65
Av.	3.28	3.18	3.45	3.33	3.24	2.98	3.07	3.80	3.00	3.46	3.36	3.16	39.31

RAINFALL AT LYNNFIELD, MASS. Elevation, 100 feet.

(Diary of General Newhall.)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1842	1.13	3.12	2.50	2.88	2.50	6.50	2.25	4.00	3.50	1.12	4.38	5.50	39.38
1843	1.88	5.00	7.00	3.87	2.00	3.38	1.87	9.87	1.25	5.00	3.00	3.75	47.87
1844	4.00	2.25	4.13	0.12	3.00	1.50	3.50	2.25	3.50	5.75	2.38	3.75	36.13
1845	4.00	4.38	2.62	1.25	2.44	2.75	2.88	1.81	2.75	4.12	10.50	6.12	45.62
1846	2.50	3.25	3.00	1.19	3.00	1.38	3.12	1.75	0.13	1.50	3.37	4.12	28.31
1847	3.38	4.25	2.37	1.88	1.75	5.12	3.75	4.38	7.50	1.13	3.62	3.37	42.50
1848	4.13	4.62	4.38	1.50	5.87	2.63	1.75	2.12	3.88	5.13	2.37	5.00	43.38
1849	0.62	1.37	4.63	1.37	4.25	1.75	1.25	5.25	1.88	7.37	5.13	3.50	38.37
1850	6.13	2.62	4.75	3.38	6.75	3.25	3.00	4.75	6.25	2.50	3.75	4.87	52.00
1851	1.63	4.37	2.25	8.25	3.25	2.50	2.13	2.62	2.00	6.00	5.63	2.75	43.38
1852	4.00	3.00	3.63	9.00	1.37	4.38	2.12	8.13	2.00	2.87	4.62	2.25	47.37
1853	3.50	6.00	1.75	3.38	5.50	0.25	3.00	9.12	4.63	4.00	5.25	4.62	51.00
1854	2.63	4.75	4.00	5.87	3.50	2.63	3.00	0.12	3.38	2.87	7.00	4.00	43.75
1855	8.00	4.25	1.13	5.12	0.88	3.00	3.00	2.75	1.75	2.75	4.37	5.50	42.50
1856	3.75	1.06	1.13	3.00	5.25	3.12	2.38	13.25	5.75	2.00	2.50	4.25	47.44
1857	4.75	1.75	3.00	7.38	4.62	1.12	4.88	6.75	1.88	4.38	2.12	4.62	47.25
1858	3.00	2.63	1.75	4.75	2.62	6.25	3.75	7.87	5.00	3.25	2.88	4.75	48.50

RAINFALL AT LYNNFIELD, MASS.—*Continued.*

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1859	5.63	5.12	6.88	2.75	3.25	5.37	2.50	5.63	4.12	2.75	3.63	7.00	54.63
1860	1.13	2.75	2.75	1.12	1.88	5.00	6.00	3.50	7.37	2.50	6.00	6.50	46.50
1861	6.00	4.00	6.13	5.50	2.06	2.25	3.13	6.12	2.63	2.37	4.38	1.62	46.19
1862	7.00	3.38	3.12	1.75	2.13	5.12	7.75	2.13	4.12	5.38	6.87	2.50	51.25
1863	4.25	4.25	6.13	7.75	2.25	2.25	10.25	5.62	2.13	3.25	5.87	5.50	59.50
1864	3.38	1.12	7.13	4.12	2.00	0.87	0.75	3.50	2.75	4.00	4.75	5.00	39.37
1865	4.88	7.12	4.63	2.37	5.75	5.25	2.63	1.50	0.25	5.37	3.88	3.12	46.75
1866	2.63	4.75	4.25	2.75	4.87	2.38	7.37	4.00	5.63	1.87	3.25	3.75	47.50
1867	3.75	5.75	5.13	2.50	4.00	2.25	5.75	9.12	0.38	7.00	1.75	2.25	49.63
1868	4.38	1.25	3.50	5.50	9.25	2.00	0.62	3.88	8.37	1.38	5.12	2.00	47.25
1869	3.75	6.50	7.00	1.75	5.25	3.00	1.88	1.12	3.38	5.62	2.25	4.50	46.00
1870	6.75	5.25	5.63	7.12	2.00	3.00	1.13	3.62	3.38	3.37	3.87	3.75	48.87
1871	2.38	3.00	3.00	2.75	3.25	4.62	2.38	3.00	1.25	6.00	6.00	3.62	41.25
1872	1.75	2.75	4.38	1.50	4.00	5.75	4.00	9.62	5.75	3.63	4.37	4.00	51.50
1873	5.50	2.88	3.37	2.50	4.00	0.38	2.50	5.50	3.50	4.75	6.50	4.75	46.13
1874	4.75	3.63	1.62	6.25	4.13	2.63	3.13	5.12	1.62	0.87	3.00	1.50	38.25
1875	4.75	3.50	5.00	4.00	3.00	6.63	1.75	3.37	3.50	4.75	4.88	1.12	46.25
1876	1.62	5.13	7.75	4.50	2.75	0.63	7.25	0.87	4.13	1.62	6.25	4.37	46.87
1877	5.13	1.12	7.50	3.63	2.75	1.62	2.63	4.62	0.25	8.00	7.75	0.75	45.75
1878	6.63	6.62	4.38	5.75	0.25	2.50	3.75	8.75	2.25	5.12	5.38	4.75	56.13
Av.	3.92	3.74	4.14	3.79	3.44	3.11	3.37	4.79	3.35	3.82	4.56	3.92	45.95

RAINFALL AT MANSFIELD, MASS. Elevation, 150 feet.

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1888	4.21	3.78	6.86	2.51	5.19	2.23	2.60	7.00	9.80	5.41	10.18	5.44	65.21
1889	6.21	2.48	1.96	4.70	4.41	3.72	10.60	4.16	5.25	5.62	6.50	3.43	59.04
1890	4.15	3.80	8.45	4.40	6.54	3.26	2.00	4.79	4.77	7.59	0.95	5.02	55.72
1891	8.20	6.61	5.63	3.07	1.03	3.66	3.86	3.52	3.20	5.84	3.08	4.62	52.32
1892	5.56	2.43	3.67	1.45	6.32	3.11	2.13	3.30	2.35	2.78	5.61	1.44	40.15
1893	3.01	7.76	3.68	4.72	5.88	2.79	1.81	5.74	2.86	5.23	2.71	5.93	52.12
1894	3.79	4.61	1.64	3.62	5.04	0.51	3.40	2.02	3.80	7.27	4.39	5.47	45.56
1895	5.81	1.30	3.74	6.45	3.76	3.07	3.94	3.06	3.53	8.92	7.49	3.25	54.32
1896	2.92	6.03	5.16	1.27	2.51	3.71	1.91	2.00	10.85	2.78	4.00	2.76	45.90
1897	5.08	3.39	3.46	3.54	5.17	3.49	5.24	4.93	3.74	0.66	8.06	4.60	51.36
1898	4.55	5.73	3.35	6.96	4.70	1.76	9.36	8.25	3.98	7.95	7.60	3.16	67.35
Av.	4.86	4.36	4.33	3.88	4.59	2.85	4.26	4.43	4.92	5.46	5.51	4.10	53.55

RAINFALL AT MIDDLEBOROUGH, MASS. Elevation, 53 feet.

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1887	...	...	...	...	...	3.08	3.23	5.12	0.98	2.85	2.33	3.62	....
1888	3.80	3.59	5.63	2.11	5.01	1.78	3.88	5.66	9.41	3.56	10.23	4.14	58.83
1889	6.15	2.56	2.38	4.47	4.05	2.42	6.74	5.39	3.62	4.68	6.69	2.35	51.50
1890	2.77	2.90	8.69	2.98	5.03	3.52	1.48	3.38	7.32	10.55	1.11	4.08	53.81
1891	7.90	5.69	4.90	3.69	2.19	1.85	2.19	3.22	1.97	5.70	3.04	3.45	45.79
1892	4.15	2.50	4.52	1.84	4.76	2.81	1.55	4.13	2.54	1.85	6.62	1.32	38.92
1893	3.43	6.51	5.35	3.41	4.35	3.96	1.62	5.21	2.42	3.26	2.67	5.56	47.75
1894	1.62	4.74	1.22	3.40	4.48	0.61	1.20	1.84	3.22	7.68	4.22	4.91	42.14
1895	2.99	1.36	3.16	4.95	3.56	2.26	1.88	2.94	1.88	6.14	4.35	3.28	38.75

RAINFALL AT MIDDLEBOROUGH, MASS. — *Continued.*

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1896	2.36	5.24	5.39	0.98	2.66	3.62	2.01	2.66	8.17	4.38	3.50	2.47	43.44
1897	4.52	2.14	2.29	3.80	4.19	3.26	4.80	2 63	1.45	0.94	6.95	3.49	40.46
1898	4.78	4.96	2.90	5.41	4.63	1.74	7.78	5.29	2.12	8.79	7.12	2.48	58.00
1899	5.35	8.81	6.53	1.88	1.52	3.96	2.99	1.75	7.12	2.99	1.09	1.33	45.32
1900	4.43	5.80	4.29	1.67	5.58	1.99	1.79	1.54	3.58	4.68	3.95	2.52	41.82
1901	2.20	1.20	7.38	7.30	7.57	1.88	2.58	2.43	3.70	3.21	2.23	8.70	50.38
1902	2.19	7.10	5.82	2.67	1.13	4.89	2.34	1.79	3.10	5.02	1.64	6.06	43.75
1903	3.94	4 94	7.02	4.17	0.49	3.38	2.33	3.56	0.68	5.35	1.67	3.35	40.88
1904	5.44	4.13	2.86	7.98	2.56	4.59	2.45	3.14	3.64	1.80	2.13	4.12	44.84
1905	3.55	1.72	2.40	2.05	1.29	7.26	5 33	2.77	5.19	1.80	1.87	3.87	39 10
1906	4.68	4.00	6.06	2.03	4.31	2.93	4.77	3.49	3.14	2.91	2.33	3.78	44.43
1907	3.09	3.83	2.17	3.58	3.47	2.26	1.09	1.47	8.51	2.90	5.02	5.75	43.14
1908	3.29	4.17	3.80	2.68	2.46	2.05	3.01	4.97	0.91	6.68	1.18	3.80	39.00
1909	4.29	5.87	3.94	6.14	2.75	1.53	1.33	2.37	4.33	1.73	3.33	3.28	40.89
1910	4.88	4.38	1.70	2.06	2.63	4.64	2.23	1.59	2.00	1.77	4.33	2.80	35.01
1911	3.00	2.77	3.63	3.32	0.97	1.51	4 62	3.30	2.96	2.57	6 80	3.35	38.80
1912	4.49	2.96	7.47	3.58	4 23	0.38	2.15	3.09	1.19	1.61	4.42	6.09	41.66
1913	4.67	2.81	3.47	5.14	1.68	1.17	1.80	2.44	2.77	11.77	2.47	3.64	43.83
Av.	4.11	4.10	4.42	3.59	3.37	2.78	2.92	3.17	3.73	4.40	3.88	3.85	44.32

RAINFALL AT MILTON, MASS. Elevation, 640 feet.
(Blue Hill Observatory.)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1886	5.17	8.29	3.05	2.16	3.94	1.52	2.26	3.95	3.08	4.87	3.16	5.54	46.99
1887	5.19	5.29	4.93	3.97	2.54	2.74	5.01	3.67	1.00	2.69	2.55	4.14	43.72
1888	3 52	2.95	6.02	2.07	3.91	1.79	1.48	6.38	9.58	4.66	8.23	5.25	55.84
1889	6.11	1.81	2.62	4.13	4.67	5.00	8.47	3.61	5.25	5.20	5.49	2.24	54.60
1890	2.63	2.96	7.44	3.67	5.77	1.85	1.55	3.07	7.49	7.99	1.11	5.26	50.79
1891	6.71	5.01	4.88	2.75	2.39	4.30	2.80	4.72	3 82	5 90	2.92	4.07	50.27
1892	4.64	1.93	3.40	0.92	5.33	3.68	3.39	5.68	2.31	2.20	5.02	1.23	39.73
1893	2.42	6.71	4.03	3.05	4.49	2.69	2.48	6.88	1.99	3.66	2.17	4.51	45.08
1894	3.18	3.53	1 21	3.33	3.13	0.74	2.98	2.39	2.69	6.56	4.10	4 40	38.24
1895	4.03	1.12	2.93	5.24	2.53	1.85	3.35	2.80	2.95	7.93	8.95	2.51	46.19
1896	2.71	4.45	5.95	1.32	2.75	3.41	3.56	2.96	10.23	4.47	3.82	1.81	47.44
1897	4.16	2.77	2.94	3.20	4 38	3.60	4.86	5.74	2.18	0.63	6.77	4.17	45.40
1898	4.24	5.28	2.72	5.99	4.12	2.70	7.41	6.56	3.02	7.16	7.19	2.30	58.69
1899	5.28	4.09	6.45	1.54	1.11	2.25	4.21	1.27	7.57	2.69	2.32	1.89	40.67
1900	4.25	6.82	4 62	1.98	5.61	4.23	3.02	1.36	4.29	4 06	5.44	2.46	48.14
1901	2.05	1.04	7.36	7.31	5.96	1.65	6.15	2.90	4.75	3.75	3.18	7.88	53.98
1902	2.05	5.73	6.75	2.81	1.38	3.78	3.15	2.76	2.94	4.54	1.33	5.49	42.71
1903	4.29	4.92	7.20	3.86	1.28	6.46	2.94	4.36	1.74	5.46	1.20	3.05	46.76
1904	6.00	3.72	3.52	8.53	2.96	2.86	2.52	2.21	6.04	2.72	1.90	3.21	46.19
1905	4.98	1.89	2.83	3.35	1.63	4.56	2.33	3.64	6.31	1.66	2.25	4.02	39 45
1906	3.27	3.27	6.04	2.50	5.30	1.83	6.49	2.06	4.18	4.22	2.56	3.81	45.53
1907	3.76	3.23	2.62	4.16	3.39	3.18	1.60	1.47	8.81	3.40	6.46	5.49	47.57
1908	3.96	4.08	3.92	1.87	4.16	1.35	4.67	3.68	1.03	4.85	1.00	3.01	37.58
1909	4.54	5.11	4.42	4.79	2.51	3.24	1.28	4.22	4.42	1.46	3.82	3.80	43.61
1910	6.32	4.43	1.82	2 50	1.37	3.80	1.75	1.73	2.06	1.54	5.70	2.61	35.63
1911	3.07	3.20	3.27	2.86	0.89	4.76	4.55	6.70	3.36	3.01	5.71	3.24	44.62
1912	3.87	2.24	5.26	4.05	4.03	0.53	4.16	3.05	1.71	1.52	3 45	5.73	39.60
1913	3.21	3.77	5.32	4.73	2.85	3.20	2 00	3.30	2.77	7.62	2.70	3.66	45.13
Av.	4.13	3.92	4.41	3.52	3.37	2.98	3.59	3.68	4.20	4.16	3.95	3.81	45.72

RAINFALL AT MONSON, MASS. Elevation, 370 feet.

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1886	4.63	5.69	3.55	1.95	3.17	2.10	3.54	4.90	2.58	3.14	5.18	4.64	45.07
1887	5.70	4.37	4.56	3.15	0.79	4.11	6.27	7.98	1.48	2.33	3.19	3.92	47.85
1888	3.58	4.49	7.01	2.16	3.69	4.01	4.07	4.00	7.44	4.95	5.25	6.21	56.86
1889	3.94	4.13	4.02	2.87	1.95	2.97	8.12	2.76	2.72	6.21	5.51	3.31	48.51
1890	3.34	3.43	6.60	2.66	5.86	2.23	5.16	4.61	3.54	5.80	0.89	3.53	47.65
1891	7.33	5.38	3.01	3.07	1.86	2.84	4.88	3.27	3.40	3.95	2.36	4.20	45.55
1892	5.15	1.57	2.55	0.44	5.87	3.56	5.26	5.69	2.58	1.08	5.22	1.32	40.29
1893	2.70	7.40	3.31	3.60	5.61	3.68	2.09	3.24	3.39	5.33	1.14	4.79	46.28
1894	3.12	3.03	1.75	2.57	2.87	1.53	1.81	1.57	2.78	3.81	4.17	2.60	31.61
1895	2.66	0.95	1.97	4.22	2.40	4.24	4.20	3.45	5.51	7.25	4.87	4.25	45.97
1896	1.79	5.94	5.32	1.75	2.90	3.10	4.85	2.03	6.20	4.10	2.38	1.63	41.99
1897	4.18	3.07	3.46	1.61	5.15	3.95	9.45	3.23	1.31	1.07	7.21	5.70	49.39
1898	5.26	3.93	2.85	3.94	3.66	3.33	6.14	10.00	3.30	5.97	7.25	3.06	58.69
1899	3.64	4.11	6.51	1.25	1.58	4.54	5.92	4.47	3.29	1.81	2.57	2.52	42.21
1900	4.51	7.58	5.88	2.30	4.90	5.18	4.53	3.54	2.08	4.01	6.30	2.83	53.64
1901	1.88	1.10	5.96	6.69	7.19	1.26	3.50	5.83	4.54	3.53	2.36	10.06	53.90
1902	2.19	7.10	5.82	2.67	1.13	4.89	2.34	1.79	3.10	5.02	1.64	6.06	43.75
1903	2.30	3.94	6.73	3.21	1.07	5.88	2.44	4.14	3.49	3.15	2.76	4.14	43.25
1904	3.95	3.46	3.72	5.07	2.35	2.49	3.85	4.72	6.80	1.97	1.65	2.94	42.97
1905	4.32	1.59	4.56	2.56	1.16	6.00	1.88	4.92	7.01	1.99	2.19	3.42	41.60
1906	2.91	2.27	5.05	2.87	5.14	3.10	8.04	2.16	2.25	5.47	2.19	3.80	45.25
1907	2.80	2.11	1.61	3.05	4.11	2.38	2.65	1.30	9.79	6.67	5.72	4.83	47.02
1908	3.55	4.44	3.62	2.31	4.96	1.36	2.34	5.56	1.50	1.73	1.10	3.00	35.47
1909	3.44	5.13	4.08	5.74	3.57	1.45	1.38	4.58	4.74	1.46	2.34	2.35	40.26
1910	5.62	4.11	1.44	2.85	2.51	3.15	2.62	4.00	2.51	1.05	3.97	2.38	36.21
1911	3.15	2.45	3.85	2.55	0.59	...	...	7.62	4.47	3.71	4.16	...	....
Av.	3.78	4.01	4.20	2.98	3.42	3.33	4.29	4.15	3.89	3.72	3.58	3.90	45.25

RAINFALL AT MONTAGUE, MASS. Elevation, 200 feet.

(Turners Falls.)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1892	3.03	1.65	2.15	0.53	5.58	3.17	3.58	7.01	2.60	0.52	5.17	1.00	35.99
1893	2.70	4.52	3.85	3.12	4.65	2.77	1.65	4.13	1.42	2.90	2.04	3.87	37.62
1894	1.75	1.72	1.30	1.41	2.06	2.37	1.39	0.69	4.86	3.95	2.98	3.18	27.66
1895	3.26	0.51	2.15	2.78	1.83	2.59	4.55	3.17	3.41	2.78	4.31	3.56	34.90
1896	1.09	2.74	7.66	1.06	2.16	1.62	3.44	3.60	6.37	2.98	3.50	0.77	36.99
1897	3.11	2.04	3.91	2.88	3.25	6.59	13.32	2.59	1.26	1.48	4.77	5.74	50.94
1898	5.79	1.86	1.30	3.25	4.26	2.73	2.46	5.68	3.73	7.02	4.42	1.52	44.02
1899	2.92	2.18	6.58	1.38	1.04	2.06	4.83	1.20	4.91	1.12	2.03	2.04	32.29
1900	3.83	6.52	1.32	5.22	2.20	2.21	2.10	2.56	2.10	2.74	4.84	2.53	38.17
1901	1.60	0.38	5.28	5.82	4.96	2.22	5.27	7.35	2.95	4.90	1.14	6.77	48.64
1902	1.36	1.79	5.98	2.84	2.13	3.13	3.78	3.75	3.18	3.96	0.92	6.12	38.94
1903	3.20	3.65	4.77	2.13	0.44	7.92	3.43	4.08	1.33	2.04	1.92	2.89	37.80
1904	2.99	2.06	3.59	3.18	2.53	3.43	3.38	4.46	6.34	1.92	0.13	2.65	36.66
1905	3.58	1.33	2.35	2.03	1.23	4.21	2.96	5.12	6.33	1.73	2.10	3.50	36.47
1906	2.05	2.28	4.25	2.47	6.03	3.55	4.90	4.38	2.25	4.62	3.12	2.58	42.48
1907	3.61	1.45	2.12	2.74	3.35	3.15	1.95	1.72	10.41	4.83	5.02	3.79	44.14
1908	2.87	4.62	3.21	2.17	5.36	1.87	3.97	6.15	1.11	1.79	0.66	2.88	36.66
1909	5.05	6.22	3.31	4.56	3.69	3.11	1.68	4.53	5.26	1.28	2.89	2.52	44.10

RAINFALL AT MONTAGUE, MASS. — *Continued.*

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1910	5.94	4.83	1.54	3.12	2.68	3.10	1.84	1.68	3.19	1.01	3.55	2.08	34.56
1911	2.58	2.26	4.44	2.02	1.62	2.60	2.72	6.64	3.63	7.58	3.52	3.18	42.79
1912	3.97	1.85	5.50	2.85	4.20	1.97	1.82	3.64	3.08	2.21	4.11	4.16	39.36
1913	3.61	2.53	5.35	2.79	3.77	0.67	1.02	2.47	2.83	3.05	2.99	2.20	33.28
Av.	3.18	2.68	3.72	2.74	3.14	3.05	3.46	3.94	3.75	3.02	3.00	3.16	38.84

RAINFALL AT NANTUCKET, MASS. Elevation, 15 feet.

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1847	0.90	...	3.00	0.45	1.25	4.79	2.31	1.55	4.41	0.91	3.91	6.15	....
1848	2.58	3.74	1.60	0.45	4.43	1.67	1.70	0.72	3.79	6.54	3.25	4.13	34.60
1849	0.08	0.50	2.67	1.36	2.03	2.69	2.74	0.21	1.55	6.87	3.60	2.78	27.08
1850	6.69	2.99	8.87	2.85	5.17	2.42	1.01	2.27	2.57	1.96	1.79	4.26	42.85
1851	1.58	3.70	2.00	4.64	6.22	2.05	2.12	2.67	2.42	6.15	3.90	4.37	41.82
1852	5.59	0.75	0.83	7.52	3.17	1.08	1.78	4.46	2.93	2.06	2.89	6.71	39.77
1853	2.38	5.75	3.94	4.25	3.78	5.01	1.72	3.85	0.94	2.64	4.77	2.97	42.00
1854	2.10	4.89	1.16	5.95	2.48	2.02	4.83	2.19	7.80	3.11	5.84	5.06	47.43
1855	4.50	3.04	3.84	8.49	5.87	4.77	2.16	1.51	1.21	4.13	3.11	6.30	48.93
1856	3.75	2.03	1.35	3.00	2.90	5.39	1.47	1.16	5.20	2.03	3.61	3.81	35.70
1857	6.75	2.21	3.97	5.96	4.87	2.90	3.07	7.03	2.51	3.25	2.22	5.14	49.88
1858	4.41	1.63	2.80	4.33	2.43	1.98	4.56	4.26	2.46	3.58	3.71	5.78	41.93
1859	7.96	4.27	4.63	3.01	4.15	5.68	2.77	3.45	3.30	3.16	1.37	4.60	48.35
1887	2.97	3.97	2.84	6.23	1.75	2.12	2.10	4.35	1.99	1.81	2.54	4.60	37.27
1888	3.48	1.50	3.14	1.43	7.87	1.51	3.68	0.87	7.30	4.99	6.49	3.45	45.71
1889	5.03	4.23	5.46	4.02	2.26	3.45	2.92	11.05	3.12	6.58	7.80	2.07	57.99
1890	3.52	2.72	6.07	1.17	2.48	3.49	2.90	2.81	8.33	6.72	0.89	2.70	43.80
1891	4.51	3.30	1.86	1.47	2.05	2.83	3.16	3.41	3.12	4.96	1.02	3.14	34.83
1892	2.23	1.46	5.88	2.76	2.57	1.81	0.91	1.79	2.01	1.66	7.63	1.67	32.38
1893	2.06	3.90	4.35	4.73	2.68	2.26	1.45	4.40	2.24	2.17	1.31	4.21	35.76
1894	3.14	3.11	1.89	2.24	1.88	0.81	0.29	1.20	1.90	10.05	2.80	5.83	35.14
1895	3.91	1.56	4.41	2.52	4.92	1.29	4.06	4.46	1.69	1.91	4.86	2.73	38.32
1896	1.57	2.67	5.97	0.62	2.35	2.43	4.12	1.38	2.06	5.03	2.29	2.68	33.17
1897	2.59	2.69	3.05	4.47	2.30	1.64	4.32	2.66	1.31	1.63	3.90	3.17	33.73
1898	2.76	1.87	2.56	2.97	3.53	0.63	2.93	2.20	0.83	3.69	5.15	2.22	31.34
1899	2.74	4.53	5.66	1.52	0.77	2.08	1.99	2.08	1.88	3.06	1.54	1.08	28.93
1900	3.20	4.86	2.95	2.61	1.65	1.50	1.89	1.56	2.59	2.57	3.96	1.88	31.22
1901	3.03	1.33	4.74	3.71	4.92	1.43	1.16	2.60	2.11	0.44	0.89	6.52	32.88
1902	2.75	2.87	4.55	2.23	0.74	6.34	1.76	0.27	2.35	4.25	1.96	5.90	35.97
1903	3.02	3.32	3.53	3.04	0.93	1.10	1.81	2.09	1.37	3.33	3.82	2.97	30.33
1904	5.98	3.86	2.11	4.08	2.39	2.38	2.09	2.25	0.78	1.01	3.29	4.67	34.89
1905	5.70	2.16	3.12	1.57	2.62	6.50	4.02	4.93	4.07	2.06	2.82	3.73	43.30
1906	4.93	3.94	7.41	2.17	2.36	1.21	4.50	6.93	2.72	2.33	1.84	4.58	44.92
1907	5.33	3.12	4.62	2.90	4.23	2.17	3.32	1.76	4.35	1.99	6.69	5.49	45.97
1908	3.78	3.71	2.74	3.55	1.27	1.66	1.00	4.28	2.98	4.97	0.95	4.89	35.78
1909	4.54	4.88	3.34	4.40	4.32	2.30	0.98	1.72	3.71	4.40	6.39	1.85	42.83
1910	6.90	3.41	2.74	2.95	3.36	6.06	4.18	2.67	0.61	4.72	3.46	4.33	45.39
1911	3.77	3.88	3.35	5.17	0.82	2.[illegible]6	3.20	8.03	3.34	2.57	6.30	3.76	46.75
1912	4.13	2.77	5.85	2.91	4.19	0.14	4.89	2.87	2.25	1.41	2.94	6.25	40.60
1913	5.57	4.44	3.17	2.19	1.71	1.59	0.58	3.26	7.76	6.49	1.91	3.21	41.88
Av.	3.88	3.12	3.72	3.37	3.09	2.59	2.57	3.12	2.96	3.65	3.47	3.98	39.52

RAINFALL AT NEW BEDFORD, MASS. Elevation, 100 feet.

1814–1875, Samuel Rodman; 1876–1905, Thomas R. Rodman; 1906–1907, Charles H. Adams; 1908–1913, L. J. Hathaway, Jr.

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1814	1.42	8.30	2.16	5.46	4.23	2.27	0.99	6.14	3.06	1.73	5.37	1.65	43.08
1815	4.55	3.32	5.02	4.66	4.11	2.22	1.96	4.36	2.51	1.47	3.45	3.15	40.78
1816	2.12	6.82	2.47	5.50	6.15	2.33	1.01	1.46	6.05	3.96	5.56	0.70	44.13
1817	3.96	5.26	1.77	2.60	1.19	7.00	0.88	3.21	4.09	1.19	6.64	5.54	43.33
1818	3.31	0.91	3.31	3.94	6.79	3.51	3.32	1.66	5.52	2.84	3.35	2.31	40.77
1819	1.25	2.54	7.30	3.31	2.06	3.32	1.57	6.00	4.81	3.84	1.92	1.74	39.66
1820	1.46	5.02	4.41	1.23	5.41	0.46	3.71	4.38	2.01	6.22	3.75	3.23	41.32
1821	2.32	5.96	2.52	6.09	5.42	3.78	2.41	2.23	4.11	4.96	2.94	2.90	45.64
1822	3.29	3.70	3.31	4.76	0.58	2.58	5.14	3.51	6.05	2.97	3.62	2.27	41.78
1823	4.84	5.00	8.43	1.83	7.67	3.20	4.63	3.90	2.08	5.06	3.51	9.74	59.89
1824	3.84	5.32	3.61	5.74	2.68	3.14	2.44	6.21	4.88	2.55	3.54	3.39	47.34
1825	2.80	2.21	6.06	1.42	2.11	3.71	2.06	3.52	1.68	2.78	1.81	7.93	38.09
1826	2.19	3.85	4.08	2.92	0.73	2.11	2.44	18.72	1.44	7.47	4.50	4.32	54.77
1827	3.14	3.99	4.88	3.46	6.94	4.42	4.36	7.63	5.65	6.68	8.42	3.33	62.90
1828	3.02	3.25	4.31	3.48	3.91	4.04	3.02	1.15	3.63	3.62	5.16	0.45	39.04
1829	9.06	5.76	7.03	4.79	8.59	2.92	3.40	7.53	3.49	3.53	7.18	2.13	65.41
1830	4.20	3.07	4.77	2.25	6.63	3.71	12.00	6.22	5.20	3.54	6.18	6.89	64.66
1831	7.47	3.53	5.24	7.38	4.45	3.52	7.26	3.32	5.86	6.04	3.68	3.43	61.18
1832	3.98	5.36	3.02	3.41	6.55	0.41	1.69	8.30	3.00	2.64	4.43	6.52	49.31
1833	3.91	2.37	1.92	2.31	4.14	4.25	1.38	2.57	1.88	5.70	5.51	6.68	42.62
1834	2.76	1.61	1.95	2.94	4.74	7.30	3.42	1.81	5.63	5.25	4.23	3.48	45.12
1835	3.35	1.80	6.52	6.84	2.65	2.52	1.56	10.16	0.90	2.99	2.97	4.95	47.21
1836	9.53	4.62	3.78	2.78	1.76	4.93	1.90	1.12	1.28	2.58	4.53	4.02	42.83
1837	3.69	3.75	4.47	3.33	6.47	4.41	2.15	4.37	0.54	1.34	1.50	3.05	39.07
1838	3.00	2.41	2.90	2.15	3.02	2.84	1.55	2.99	6.71	5.38	4.36	0.97	38.28
1839	0.77	2.71	2.44	4.83	4.96	2.51	2.76	5.89	3.38	5.86	2.01	6.26	44.38
1840	3.25	2.68	3.99	4.56	5.82	3.69	2.14	2.88	3.07	6.93	7.52	3.06	49.59
1841	5.57	1.75	4.06	9.27	1.66	1.44	3.05	5.05	2.90	4.70	5.30	5.85	50.60
1842	2.47	4.34	2.89	3.77	3.17	7.40	1.34	1.97	2.00	0.86	3.06	5.79	39.06
1843	3.94	4.18	4.02	6.19	1.39	1.45	3.31	7.13	1.77	6.86	5.09	5.34	50.67
1844	4.19	2.18	6.65	1.79	2.60	0.90	3.08	2.49	4.15	4.56	4.01	4.13	40.73
1845	4.16	3.00	3.04	1.87	3.79	2.34	3.09	3.37	4.49	4.29	9.72	4.90	48.06
1846	3.09	2.57	1.74	1.20	6.40	0.99	2.61	3.07	2.48	1.68	3.80	4.88	34.51
1847	3.33	4.57	3.25	1.66	2.64	6.46	2.41	7.15	7.20	0.62	1.52	5.10	45.91
1848	3.75	4.22	2.89	1.46	3.88	2.99	4.04	1.16	1.89	5.43	3.30	5.73	40.74
1849	0.88	2.07	5.70	2.23	2.43	1.59	1.22	4.88	1.24	5.71	5.15	3.32	36.42
1850	5.87	2.22	6.05	9.25	4.49	1.23	2.26	6.29	12.06	2.62	2.82	7.51	62.67
1851	2.24	6.20	3.27	4.84	4.78	1.18	9.22	3.49	3.75	5.37	4.76	2.51	51.61
1852	3.91	3.57	5.50	7.86	3.50	1.71	2.55	5.49	2.01	2.03	3.66	4.35	46.14
1853	1.69	4.67	1.28	3.92	4.36	0.92	3.95	2.95	3.84	3.52	3.92	4.45	39.47
1854	1.99	5.67	2.15	6.83	3.56	3.02	7.44	0.24	8.37	1.48	9.66	3.40	53.81
1855	4.72	2.62	1.95	4.24	3.64	1.84	4.79	1.42	0.62	4.66	4.82	5.68	41.00
1856	5.18	1.27	1.64	3.20	3.96	2.12	3.32	2.81	4.56	1.89	3.26	3.88	37.09
1857	6.20	1.84	2.52	5.90	3.69	2.30	4.62	3.94	2.32	2.64	1.84	5.49	43.30
1858	2.46	1.28	2.28	4.39	2.02	5.16	6.75	5.05	3.02	3.20	3.84	4.58	44.03
1859	8.53	4.40	6.64	3.44	5.11	6.16	0.96	4.02	3.64	2.07	2.10	4.34	51.44
1860	1.37	3.50	2.82	2.86	2.80	3.26	2.96	5.00	5.24	1.82	3.44	4.65	39.72
1861	4.19	3.25	4.06	5.44	4.42	3.12	1.70	5.00	3.50	4.30	4.58	2.90	46.46
1862	3.27	3.88	2.80	1.66	2.86	8.05	3.06	1.20	3.98	5.62	4.47	2.46	43.31
1863	2.75	4.16	4.26	4.34	3.52	2.49	4.26	2.51	2.50	1.90	7.03	5.37	45.09

RAINFALL AT NEW BEDFORD, MASS. — *Continued.*

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1864	4.35	1.51	5.52	3.10	2.93	1.08	1.50	7.68	2.28	2.35	4.18	4.48	40.96
1865	5.51	3.92	4.90	3.24	6.36	1.66	5.15	1.21	0.26	4.93	4.47	4.40	46.01
1866	2.30	4.54	3.70	2.06	4.15	4.18	1.86	3.60	5.32	2.64	2.65	3.31	40.31
1867	2.84	5.08	5.58	3.18	3.85	2.36	6.03	5.70	2.44	3.96	1.99	4.10	47.11
1868	6.17	2.43	4.64	5.96	9.42	6.51	3.78	4.50	5.91	1.68	2.98	2.34	56.32
1869	3.97	5.34	6.22	1.42	5.92	4.45	1.62	2.76	2.62	6.75	2.30	6.56	49.93
1870	6.20	4.55	3.46	6.20	3.50	3.62	3.05	1.69	1.28	6.64	3.28	3.70	47.17
1871	3.26	3.28	4.86	3.93	2.68	5.39	1.92	6.35	2.24	6.38	6.98	2.34	49.61
1872	2.64	2.42	5.33	2.27	3.51	2.68	6.40	4.04	4.58	5.79	3.58	4.42	47.66
1873	7.24	4.93	2.89	3.98	4.95	1.44	1.22	4.16	3.17	5.34	6.32	6.06	51.70
1874	4.27	4.27	1.59	8.57	5.11	3.70	3.84	7.66	2.94	0.55	3.49	3.34	49.33
1875	3.78	3.67	7.86	4.04	4.20	4.98	4.00	4.60	2.38	3.02	4.85	0.94	48.32
1876	1.02	4.85	5.54	3.85	1.68	0.73	3.86	1.23	1.40	1.52	8.42	5.09	42.19
1877	3.06	1.79	9.42	3.13	2.92	2.36	4.93	3.39	0.83	7.66	6.60	0.95	47.04
1878	5.97	4.05	4.77	4.94	2.91	2.97	2.36	5.38	1.04	5.93	5.74	4.49	50.55
1879	3.42	3.00	5.56	5.12	1.83	2.78	3.59	4.37	3.18	1.19	3.55	4.72	42.31
1880	2.06	2.97	4.85	3.49	1.37	1.96	6.59	5.62	1.68	3.11	2.44	3.92	40.06
1881	4.14	5.83	4.74	1.79	2.39	5.14	1.65	0.79	3.29	1.52	5.78	2.04	39.10
1882	4.14	6.23	2.48	4.06	4.74	1.70	1.52	0.89	6.26	4.00	1.91	3.45	41.38
1883	4.73	4.67	2.08	2.93	3.60	1.46	6.92	0.85	2.74	6.36	3.28	3.89	43.51
1884	4.85	5.72	5.29	5.17	3.33	5.38	4.80	8.49	0.98	1.63	3.55	5.80	54.99
1885	5.20	2.76	1.49	2.66	3.15	4.06	1.17	4.23	1.85	4.04	3.16	3.04	36.81
1886	6.77	7.05	5.09	2.19	4.39	1.99	2.69	2.76	2.15	4.23	3.76	6.78	49.85
1887	6.02	6.25	5.83	5.45	2.24	3.15	3.61	6.68	1.71	3.95	2.60	4.28	51.77
1888	4.38	2.63	5.66	2.42	5.57	1.45	5.17	4.89	9.52	2.66	7.39	3.33	55.07
1889	5.79	2.92	2.83	4.31	5.14	3.83	5.44	5.73	3.87	4.11	6.07	2.67	52.71
1890	2.66	2.36	9.77	4.09	6.73	5.90	1.91	3.82	7.55	10.09	1.32	5.49	61.69
1891	8.36	7.00	5.81	2.78	2.44	1.55	1.97	2.09	2.31	6.97	3.17	3.38	47.83
1892	4.48	2.34	5.78	2.31	5.46	2.23	1.72	4.58	3.65	1.86	6.78	1.64	42.83
1893	2.70	6.90	6.18	5.13	4.49	3.00	2.40	4.26	3.38	2.45	2.63	6.75	50.27
1894	4.85	5.18	1.84	4.99	4.46	0.90	0.74	2.18	2.83	7.64	4.55	5.73	45.89
1895	4.04	1.17	4.72	4.22	3.39	3.01	4.91	3.02	1.50	4.29	4.52	2.84	41.63
1896	2.03	4.43	5.97	1.21	3.91	4.98	2.90	3.79	8.87	3.40	2.60	3.61	47.73
1897	3.57	2.53	2.79	4.30	6.07	2.48	3.85	8.57	0.88	1.42	9.74	4.36	50.56
1898	5.78	5.28	3.50	5.29	6.82	0.94	6.04	7.68	1.28	9.83	7.98	2.18	62.60
1899	5.30	5.31	7.35	2.08	1.21	3.72	3.97	2.29	6.50	3.51	1.11	1.99	44.34
1900	5.24	4.62	3.73	2.66	5.31	1.12	2.57	1.63	4.19	6.58	4.65	2.69	44.99
1901	2.66	1.26	7.85	7.08	8.57	1.79	3.22	2.24	3.31	2.12	1.69	10.05	51.84
1902	2.38	5.78	6.91	3.72	1.36	2.48	3.21	2.09	3.92	6.19	1.85	5.53	45.42
1903	4.77	4.52	8.02	5.77	0.81	4.13	2.22	4.47	1.71	4.15	3.57	3.35	47.49
1904	4.99	4.65	2.38	8.84	3.55	5.46	2.22	6.15	2.92	1.36	2.29	5.27	50.08
1905	3.73	2.10	2.88	1.61	1.65	6.77	2.29	4.63	6.36	1.96	3.02	4.30	41.30
1906	3.66	4.21	5.73	2.51	3.51	3.32	4.72	2.26	5.14	3.11	3.16	1.75	43.08
1907	3.35	1.95	3.36	3.25	6.33	2.66	1.09	1.07	7.30	2.52	5.80	6.83	45.51
1908	4.16	4.66	3.60	1.75	4.02	1.69	2.02	5.29	1.27	7.54	1.45	4.43	41.88
1909	4.39	6.44	3.52	6.09	3.50	1.83	0.67	2.27	3.99	1.99	4.73	3.21	42.63
1910	5.65	5.59	1.59	1.86	3.25	4.26	2.49	2.64	1.38	2.03	4.11	3.17	38.02
1911	3.71	2.73	3.22	4.09	0.97	1.92	5.32	4.03	2.46	2.33	7.22	4.12	42.12
1912	4.97	3.69	8.40	3.45	4.67	0.10	1.03	5.49	2.30	1.19	3.82	6.65	45.76
1913	4.82	4.09	3.61	4.59	1.64	0.85	1.97	4.26	2.35	10.09	2.62	4.68	45.57
Av.	4.01	3.88	4.34	3.95	3.96	3.07	3.23	4.17	3.52	3.94	4.25	4.15	46.47

RAINFALL AT NEW BEDFORD, MASS. Elevation, 60 feet.

(Old Water Works Pumping Station.)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1886	6.47	7.49	4.76	2.17	3.99	1.98	2.83	2.74	2.31	4.47	4.19	6.67	50.07
1887	7.18	5.64	4.74	4.98	2.27	3.22	2.92	4.94	1.81	3.73	2.63	4.05	48.11
1888	5.04	2.97	5.78	2.77	5.95	1.00	4.67	5.02	9.31	3.07	7.24	3.50	56.32
1889	5.91	2.75	2.69	4.22	5.40	3.52	7.57	3.58	4.12	3.88	6.59	2.62	52.85
1890	2.78	2.85	8.53	3.65	6.52	5.53	1.98	3.75	7.73	9.73	1.30	5.02	59.37
1891	9.17	5.78	5.61	2.89	2.22	1.63	2.17	2.17	1.97	6.41	3.07	3.71	46.80
1892	4.33	2.22	5.36	2.29	5.15	2.21	1.91	3.82	3.54	1.85	6.52	1.50	40.70
1893	3.78	8.15	6.08	6.07	5.06	3.13	1.96	5.22	3.31	2.61	3.07	6.67	55.11
1894	5.13	4.49	1.88	4.30	4.60	0.77	0.80	1.98	2.91	7.63	4.25	5.84	44.58
1895	3.85	0.83	4.49	4.57	4.23	3.54	4.84	2.51	2.26	4.04	4.99	2.63	42.78
1896	2.19	4.33	5.72	1.23	3.82	4.82	2.58	3.58	7.76	3.46	2.93	3.63	46.05
1897	3.73	2.69	2.81	4.28	5.81	2.86	4.30	7.56	1.01	1.55	9.43	4.62	50.65
1898	5.50	5.88	3.52	5.36	6.40	1.40	5.74	7.32	2.24	10.14	8.28	2.41	64.19
Av.	5.00	4.31	4.77	3.75	4.72	2.74	3.41	4.17	3.87	4.81	4.96	4.07	50.58

RAINFALL AT NEWBURYPORT, MASS. Elevation, 80 feet.

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1886	7.76	6.75	3.29	1.86	3.72	1.58	3.05	2.80	3.32	3.12	4.31	5.80	47.36
1887	5.82	6.18	5.24	4.99	1.34	2.34	4.35	7.57	1.76	3.10	3.90	3.62	50.21
1888	5.13	4.65	6.25	3.54	5.58	1.59	2.54	5.35	8.47	5.66	6.74	4.76	60.26
1889	5.89	2.30	2.90	3.55	4.13	4.35	6.79	2.89	2.82	4.71	8.15	3.52	52.00
1890	2.85	4.27	6.94	1.78	6.08	3.43	2.90	4.83	3.39	7.20	1.52	5.51	50.70
1891	6.86	4.83	4.51	2.10	2.39	3.79	3.67	2.04	1.66	4.32	2.34	3.27	41.78
1892	4.70	2.67	3.65	0.60	5.71	4.86	1.37	4.01	1.94	1.32	5.50	0.93	37.26
1893	1.23	5.56	2.31	1.71	4.70	1.46	1.34	3.72	0.30	2.75	2.31	5.03	32.42
1894	3.42	**2.50**	**1.11**	0.80	3.77	0.15	3.96	0.48	4.54	3.76	1.15	2.39	28.03
Av.	4.85	4.41	4.02	2.33	4.16	2.62	3.33	3.74	3.14	3.99	3.99	3.87	44.45

RAINFALL AT NEWTON, MASS. Elevation, 100 feet.

(Water Works Pumping Station.)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1908	3.54	3.67	3.59	1.58	4.56	1.05	3.74	4.71	0.72	3.23	0.96	2.88	34.23
1909	3.79	5.11	3.88	4.01	2.06	2.95	1.40	3.11	5.07	1.13	3.65	3.07	39.23
1910	5.60	4.03	1.40	2.43	1.51	4.67	1.65	1.08	2.19	1.32	4.63	2.12	32.63
1911	2.50	3.02	2.90	2.74	0.47	3.44	4.72	5.20	3.15	2.84	4.27	3.51	38.76
1912	2.84	2.35	5.13	3.84	4.39	0.53	4.33	3.06	1.65	1.86	2.81	4.99	37.78
1913	2.76	3.24	5.17	4.60	3.59	0.95	1.89	3.33	3.29	6.65	2.21	3.14	40.82
Av.	3.51	3.57	3.68	3.20	2.76	2.27	2.95	3.41	2.68	2.84	3.09	3.28	37.24

RAINFALL AT NORFOLK, MASS. Elevation, 244 feet.

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1903	2.89	2.47	4.26	3.76	0.70	5.88	3.65	4.00	1.61	4.58	1.29	2.99	38.08
1904	4.05	2.92	3.23	8.54	1.80	2.23	1.59	2.86	6.67	2.73	1.60	2.60	40.82
1905	3.39	1.42	1.34	2.00	1.16	5.47	1.04	3.07	5.57	0.96	1.30	3.22	29.94
1906	2.72	2.70	4.40	1.74	5.48	2.04	7.05	2.53	3.53	7.52	2.03	1.87	43.61
1907	3.74	1.64	1.29	2.85	2.64	2.52	0.89	0.95	8.70	3.81	5.60	4.32	38.95
1908	3.80	5.05	3.53	1.69	5.58	1.36	4.42	4.44	1.20	2.85	0.96	2.63	37.51
1909	2.89	4.40	2.50	3.04	1.84	3.52	0.99	3.76	4.57	1.50	2.07	3.32	34.40
1910	4.30	2.62	1.20	1.52	1.74	4.06	2.29	0.83	2.21	1.84	5.91	4.05	32.57
1911	4.61	3.66	3.55	3.06	1.63	2.91	4.30	8.34	5.72	4.88	5.46	2.71	50.83
1912	3.34	1.52	**5.89**	3.28	4.97	0.32	3.13	3.38	0.78	3.07	3.42	6.13	39.23
1913	3.36	3.63	4.55	5.33	2.76	1.41	4.51	3.60	4.37	7.38	3.00	3.32	47.22
Av.	3.55	2.91	3.25	3.35	2.76	2.88	3.08	3.43	4.08	3.74	2.97	3.38	39.38

RAINFALL AT NORTH ADAMS, MASS. Elevation, 1 200 feet.
(Notch Brook Reservoir.)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1900	3.95	6.54	3.42	2.03	2.87	3.75	4.63	4.39	1.20	2.80	3.59	1.69	40.86
1901	1.85	1.15	4.07	6.15	5.46	2.20	4.69	6.83	3.41	2.30	2.29	7.42	47.82
1902	1.85	2.03	5.10	6.40	2.17	4.96	4.72	4.01	3.89	4.46	0.99	5.75	46.33
1903	1.68	3.86	4.64	1.74	0.63	9.16	3.38	7.64	1.56	3.55	1.92	4.02	43.78
1904	3.80	2.13	3.34	3.64	2.78	4.09	2.04	4.53	5.43	2.28	1.40	2.54	38.00
1905	4.14	1.16	2.39	2.14	1.70	3.87	3.95	5.62	5.19	1.88	2.49	3.34	37.87
1906	2.59	2.82	3.93	3.02	4.58	2.69	5.90	3.67	1.91	3.18	2.11	3.04	39.44
1907	2.98	3.09	1.48	1.83	2.47	3.35	3.15	1.00	6.48	8.00	3.36	3.75	40.94
1908	2.14	6.11	2.09	1.98	4.63	2.23	5.02	3.70	0.60	1.22	0.24	3.00	32.96
1909	4.50	4.38	3.43	4.22	2.90	4.14	1.78	4.76	3.98	1.49	2.10	2.13	39.81
1910	4.78	5.35	1.01	3.08	3.92	3.88	2.17	1.87	3.97	1.52	3.43	2.29	37.27
1911	3.36	2.02	4.72	1.34	2.24	3.75	2.45	5.19	5.19	6.26	3.47	2.70	42.69
1912	2.59	1.10	4.96	3.82	2.83	**1.72**	2.49	1.66	2.49	4.57	2.89	2.15	33.27
1913	2.69	1.65	5.55	2.65	3.63	1.10	3.47	1.63	2.85	4.44	2.70	2.79	35.15
Av.	3.06	3.10	3.58	3.15	3.06	3.63	3.56	4.04	3.44	3.42	2.36	3.33	39.73

RAINFALL AT NORTH ADAMS, MASS. Elevation, 1 000 feet.
(Broad Brook Reservoir.)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1900	4.52	5.76	4.67	1.82	2.50	3.72	4.72	7.50	1.48	3.94	4.95	2.87	48.45
1901	1.54	0.58	4.75	6.03	5.10	2.28	4.47	8.64	3.79	2.12	2.00	6.60	47.90
1902	1.75	1.93	5.67	5.54	3.94	6.66	5.52	4.15	3.71	3.97	1.64	5.45	49.93
1903	2.78	4.00	4.21	2.36	0.65	10.11	4.18	7.96	1.41	5.08	2.25	2.58	47.57
1904	3.36	1.63	3.01	**3.72**	2.92	7.00	3.52	5.49	6.28	3.54	1.56	2.10	44.13
1905	3.91	1.58	3.71	1.93	1.61	5.56	4.87	5.08	4.47	2.28	2.54	3.72	41.26
1906	2.23	2.42	3.31	3.74	5.57	4.20	6.13	3.21	2.08	3.15	2.22	2.53	40.79
1907	3.45	1.17	1.65	2.54	2.37	2.53	4.75	1.34	6.39	6.20	3.54	3.32	39.25
1908	1.93	3.11	1.76	7.69	4.22	3.53	5.99	3.40	0.48	1.82	0.98	2.40	37.31
1909	3.52	4.03	2.31	1.78	3.07	3.32	1.15	5.49	4.23	1.16	1.86	2.03	33.95
1910	5.41	4.03	1.21	2.99	5.54	2.77	2.27	1.83	4.84	1.60	3.16	2.26	37.91
1911	3.62	1.22	3.75	1.67	1.48	3.95	1.80	4.48	4.36	4.85	3.56	2.87	37.61
1912	2.49	1.61	3.89	3.62	5.93	2.06	2.80	4.23	2.09	5.11	3.23	4.37	41.43
1913	3.83	2.98	6.80	2.76	2.86	1.21	4.77	1.31	3.05	4.28	2.62	2.48	38.95
Av.	3.17	2.57	3.62	3.44	3.41	4.21	4.07	4.58	3.47	3.51	2.58	3.26	41.89

RAINFALL AT NORTHAMPTON, MASS. Elevation, 125 feet.
(Hancock Street.)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1881	4.06	3.84	5.11	1.87	5.26	4.43	2.79	3.31	2.15	3.39	4.79	5.70	46.70
1882	4.65	4.44	3.69	1.76	6.05	2.59	2.38	0.75	12.41	1.59	0.99	2.31	43.61
1883	3.03	4.39	1.84	2.75	5.71	3.38	4.59	1.43	3.20	4.83	1.95	3.37	40.47
1884	4.80	6.99	5.68	2.65	2.74	2.04	5.80	6.89	0.82	3.49	4.16	6.41	51.57
1885	4.66	3.21	1.07	3.52	2.33	3.66	2.38	7.98	1.12	5.32	6.99	3.97	46.21
1886	5.61	4.33	3.32	3.57	3.46	2.33	5.17	2.07	6.23	3.85	6.32	4.21	50.47
1887	6.66	5.85	5.33	4.32	1.73	4.91	8.91	6.73	1.74	2.35	3.83	5.51	57.87
1888	4.68	4.96	5.75	1.07	5.27	6.69	2.78	5.11	13.43	5.95	5.41	4.59	68.69
Av.	4.77	4.64	3.97	3 06	4.07	3.75	4.35	4.28	5.14	3.85	4.31	4.51	50.70

RAINFALL AT NORTHAMPTON, MASS. Elevation, 350 feet.
(Leeds.)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1883	3.21	4.23	2.46	3.12	5.15	2.45	4.08	1.79	2.90	4.79	1.84	3.16	39.18
1884	4.98	5.81	5.27	2.75	3.48	1.75	5.30	7.36	1.18	2.23	3.45	6.41	49.97
1885	4.66	4.42	1.14	3.71	1.53	3.50	2.61	7.14	0.93	5.18	6.84	2.42	44.08
1886	6.06	2.71	3.28	3.24	3.77	2.23	3.64	2.05	6.01	3.97	5.66	3.66	46.28
1887	6.60	5.69	5.60	4.21	1.90	5.07	7.70	8.92	1.56	2.59	3.31	6.40	59.55
1888	5.93	4.77	7.71	3.37	6.04	4.00	3.35	5.77	11.00	5.78	5.72	3.29	66.73
1889	4.46	1.81	1.53	2.63	4.00	7.17	9.44	2.62	5.16	4.15	7.30	3.29	53.56
1890	2.98	4.53	5.81	1.96	5.43	2.11	6.24	5.86	6.75	7.91	1.42	3.25	54.25
1891	8.34	4.47	3.83	4.85	2.32	6.04	5.52	3.81	2.82	2.76	2.80	4.72	52.28
1892	5.28	2.29	2.68	1.14	6.19	4.23	3.79	6.72	2.15	0.62	4.93	3.38	43.40
1893	0.83	6.35	3.15	3.31	8.29	2.72	1.58	5.51	2.23	5.57	2.80	4.79	47.13
1894	2.26	3.97	1.16	1.96	6.62	1.52	0.80	0.26	4.36	6.57	3.25	4.64	37.37
1895	3.38	1.29	2.12	5.12	1.88	4.04	4.40	3.31	3.27	6.71	4.00	4.93	44.45
1896	1.99	6.70	11.45	1.87	2.58	2.94	4.72	3.74	6.19	2.97	3.87	1.04	50.06
1897	3.75	3.52	3.48	2.32	4.34	6.56	12.36	4.89	2.24	0.88	5.66	5.46	55.46
1898	6.41	4.45	2.44	4.36	7.04	4.77	3.57	6.87	3.22	7.49	6.54	3.84	61.00
1899	3.34	3.80	7.77	1.93	1.61	5.54	7.00	3.03	6.87	2.41	2.39	2.65	48.34
1900	3.65	8.70	5.00	1.85	5.03	2.27	3.59	4.17	1.84	3.46	5.91	2.95	48.42
Av.	4.34	4.42	4.21	2.98	4.29	3.83	4.98	4.66	3.93	4.22	4.32	3.90	50.08

RAINFALL AT NORTHBRIDGE, MASS. Elevation, 350 feet.
(Whitinsville.)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1872	1.80	1.28	3.51	1.52	2.88	4.10	5.40	8.08	5.48	3.32	4.05	3.28	44.70
1873	1.66	4.62	2.04	3.18	4.20	0.20	2.96	5.96	2.98	6.22	3.88	4.50	42.40
1874	4.46	4.08	1.12	6.70	2.96	3.48	4.24	5.36	1.68	0.68	2.20	2.39	39.65
1875	2.46	4.58	4.50	4 08	2.80	4.66	2.64	4.00	2.26	4.74	4.98	0 88	42.58
1876	1.56	3.92	9.64	4.92	2.56	1.90	5.38	0.68	4.38	2.20	5.44	3.56	46.14
1877	3.48	1.26	9.88	2.98	3.58	3 28	1.40	8.64	0.36	8.68	7.08	1.12	51.74
1878	6.53	1.34	4.60	5.58	0 96	3.85	3.34	4.96	1.18	5.60	6.62	6.10	53 66
1879	2.15	4.06	4.28	5.96	1.60	4.68	3.30	6 40	1.72	0.48	2.60	3.58	40.81
1880	3.62	4.24	3.00	3.12	1.50	1.32	4.32	4.18	1.94	3.34	1.80	2.32	34.70
1881	5.60	5.36	6.48	2.12	2.25	4 40	2 46	1.14	1 70	3 72	3.41	4 06	42 70

RAINFALL AT NORTHBRIDGE, MASS. — *Continued.*

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1882	5.28	4.52	3.00	2.36	4.76	1.40	1.64	1.48	7.80	2.14	1.24	2.72	38.34
1883	3.40	4.32	2.04	1.80	5.55	2.11	1.81	0.87	1.81	5.93	2.04	2.89	34.57
1884	6.63	6.76	5.16	5.17	3.31	4.89	3.22	4.59	1.04	2.88	2.65	5.78	52.08
1885	5.49	4.76	1.20	3.21	4.14	1.74	0.91	7.34	1.97	4.69	4.08	3.50	43.03
1886	5.81	7.14	3.70	3.34	3.49	1.73	4.37	4.35	3.58	3.26	5.05	5.36	51.18
1887	6.64	5.34	5.52	3.59	1.54	2.68	5.56	5.72	1.48	3.12	2.66	5.26	49.11
1888	4.76	4.51	7.50	3.10	4.79	2.15	1.54	5.67	8.23	5.11	7.17	5.42	59.95
1889	7.09	1.78	2.01	3.90	2.72	4.08	10.51	4.78	4.41	5.05	5.95	3.04	55.32
1890	2.71	3.38	8.27	2.87	5.00	2.27	2.02	5.63	4.98	9.94	1.03	5.66	53.76
1891	7.95	5.36	6.46	3.16	1.75	3.14	3.91	3.65	2.51	4.13	3.30	3.93	49.25
1892	5.71	2.01	3.40	0.83	6.76	4.75	4.64	7.51	2.73	1.41	6.89	1.26	47.90
1893	3.60	7.90	4.59	3.65	7.14	2.49	1.02	4.56	1.69	5.79	2.54	4.95	49.92
1894	3.66	3.60	1.79	3.49	4.01	0.95	1.83	3.55	2.29	5.11	3.69	3.81	37.78
1895	3.87	0.95	2.91	3.92	2.55	3.21	3.26	4.16	2.86	9.87	6.23	3.01	46.80
1896	2.04	5.94	6.01	0.88	1.79	4.01	2.40	2.66	6.92	3.28	3.14	1.50	40.57
1897	2.88	2.83	4.01	2.56	3.92	3.41	6.56	4.46	1.81	0.52	6.62	5.08	44.66
1898	3.59	4.22	2.23	4.15	3.59	2.95	8.98	5.82	3.18	6.29	5.66	2.80	53.46
1899	3.83	3.21	5.50	2.08	1.27	3.22	4.31	1.19	4.40	2.32	2.54	1.72	35.59
1900	4.16	7.92	6.31	2.56	4.70	5.02	3.32	3.00	3.02	4.11	5.82	2.69	52.63
1901	1.61	0.90	6.56	8.12	6.56	1.67	4.70	6.85	4.61	2.67	2.62	8.69	55.56
1902	2.34	4.07	4.31	2.94	1.78	2.78	3.42	3.28	4.58	4.94	0.92	6.28	41.64
1903	3.94	4.11	6.48	3.34	0.78	9.04	3.56	4.54	1.14	4.41	1.55	3.13	46.02
1904	3.92	2.49	2.95	8.47	1.82	2.76	3.47	4.84	5.69	1.74	1.72	2.99	42.86
1905	4.07	1.66	2.65	3.07	1.15	5.15	4.26	3.81	6.38	1.85	2.53	3.60	40.18
1906	2.60	2.77	5.58	3.28	6.40	3.09	4.62	1.93	3.68	5.59	2.57	4.13	46.24
1907	3.00	1.93	1.56	2.66	3.52	3.26	2.03	0.98	8.59	4.75	6.67	4.31	43.26
1908	3.53	5.04	3.83	2.20	5.02	2.04	3.66	6.57	1.04	2.46	1.04	3.26	39.69
1909	3.08	5.55	3.90	4.56	2.76	2.39	2.30	3.28	5.35	1.20	2.84	3.83	41.04
1910	6.36	4.43	0.76	2.19	1.33	4.97	1.66	1.83	1.94	1.71	4.09	2.23	33.50
1911	3.04	2.24	3.44	2.87	2.46	1.70	3.39	5.77	5.00	3.78	5.01	3.58	42.28
1912	2.42	2.50	6.79	4.08	4.93	0.56	3.68	3.22	1.33	2.22	3.82	5.28	40.83
1913	3.85	2.78	6.07	4.52	3.62	1.61	2.81	4.93	3.80	7.00	2.95	3.08	47.02
Av.	3.96	3.92	4.42	3.55	3.34	3.07	3.59	4.34	3.42	4.00	3.78	3.73	45.12

RAINFALL AT PEABODY, MASS. Elevation, 75 feet.
(Water Works Pumping Station.)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1903	3.07	3.42	6.11	4.70	0.26	9.06	2.89	3.78	2.21	3.30	1.18	2.56	42.54
1904	4.29	2.76	2.38	9.59	4.76	3.95	0.89	2.99	5.39	2.26	1.51	2.11	42.88
1905	3.69	1.28	2.23	2.53	1.32	6.75	0.89	2.92	7.52	1.30	2.56	3.89	36.88
1906	2.73	2.44	4.89	2.59	5.20	3.47	5.29	2.01	2.16	3.78	3.27	4.70	42.53
1907	2.91	1.96	2.12	3.80	3.26	2.98	3.04	1.42	3.04	2.63	7.08	4.58	38.82
1908	2.96	4.29	3.32	2.35	4.80	1.07	4.02	4.37	0.65	4.45	1.57	2.64	36.49
1909	4.91	5.27	3.66	4.78	2.12	3.62	3.31	3.11	5.45	1.70	5.21	2.94	46.08
1910	4.15	4.63	1.60	2.64	1.95	5.02	2.61	1.37	2.70	1.85	3.91	1.56	33.99
1911	2.65	3.08	3.59	2.38	0.68	4.51	5.94	4.40	3.09	3.22	4.50	3.91	41.95
1912	2.89	2.82	4.52	4.27	5.37	0.24	4.07	2.18	2.54	1.70	3.30	4.54	38.44
1913	2.82	2.75	4.31	4.60	3.50	1.28	3.01	3.65	3.08	6.26	2.37	3.23	40.86
Av.	3.37	3.15	3.52	4.02	3.02	3.81	3.27	2.93	3.45	2.95	3.31	3.33	40.13

RAINFALL AT PITTSFIELD, MASS. Elevation, 1 050 feet.
(City Hall.)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1895	2.29	1.40	1.85	4.17	2.32	2.35	4.34	2.38	3.62	2.23	4.33	3.83	35.11
1896	1.13	5.03	6.63	1.30	1.40	3.40	4.15	3.90	6.70	2.74	2.62	1.41	40.41
1897	3.52	2.46	3.16	3.67	3.66	5.01	12.19	4.61	1.28	1.55	7.05	5.77	53.93
1898	5.80	3.74	2.35	3.59	5.33	7.36	2.87	9.26	2.41	8.04	4.92	2.46	58.13
1899	2.42	3.07	6.55	0.87	2.51	2.82	8.84	2.56	5.82	1.56	1.77	2.60	41.39
1900	3.89	6.80	3.83	2.27	2.99	3.62	2.12	4.69	1.89	2.52	4.38	2.08	41.08
1901	1.28	0.78	4.96	5.97	6.56	1.38	3.30	7.52	4.80	1.84	2.80	7.07	48.26
1902	1.64	2.07	5.12	3.32	2.41	6.08	6.87	2.84	5.10	4.33	0.94	5.32	46.04
1903	2.76	3.92	4.83	2.04	0.82	11.38	4.27	5.49	1.03	4.78	2.32	3.33	46.97
1904	2.26	2.07	2.67	3.43	2.48	4.62	2.61	5.48	4.55	2.28	1.50	2.71	36.66
1905	4.64	0.95	3.50	1.79	1.33	4.29	4.80	6.08	4.43	2.88	2.37	2.49	39.55
1906	2.08	2.04	4.97	3.55	4.36	2.36	5.38	3.94	3.62	3.31	2.21	2.45	40.27
1907	3.25	1.72	1.13	2.07	3.27	4.61	2.37	1.58	7.90	7.13	3.34	3.99	42.36
1908	3.06	4.17	2.22	1.84	4.19	2.45	4.07	3.53	0.53	1.42	0.67	2.74	30.89
1909	4.09	4.13	4.50	3.56	1.85	3.30	1.76	6.38	3.58	0.96	1.77	2.74	38.62
1910	3.80	4.09	1.50	3.25	4.45	2.84	2.86	2.89	5.32	1.10	3.45	1.99	37.54
1911	2.91	1.48	3.51	2.00	0.66	4.37	1.83	5.91	3.39	5.41	2.87	2.95	37.29
1912	2.19	1.67	4.53	5.16	5.73	1.38	2.38	3.76	5.13	4.46	2.79	3.99	43.17
1913	3.67	3.21	5.77	3.16	3.13	1.06	2.22	1.50	2.30	5.27	2.84	3.00	37.13
Av.	2.98	2.89	3.87	3.00	3.13	3.93	4.17	4.44	3.86	3.36	2.89	3.31	41.83

RAINFALL AT PLYMOUTH, MASS. Elevation, 50 feet.

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1887	5.91	4.15	5.06	5.26	2.16	3.01	1.65	5.07	1.57	2.97	3.14	4.51	44.46
1888	3.87	3.47	4.91	2.06	4.87	0.67	3.34	5.14	6.67	3.49	7.86	3.93	50.28
1889	4.96	2.61	2.72	6.66	3.20	2.85	6.32	6.54	2.57	3.29	6.02	1.30	49.04
1890	2.38	3.60	10.14	3.50	5.37	3.41	1.17	3.01	6.20	9.38	0.69	3.61	52.46
1891	8.36	5.32	5.04	4.02	1.99	2.23	2.55	3.18	2.23	5.72	1.79	3.77	46.20
1892	3.79	3.72	5.15	1.26	3.91	2.12	1.81	4.16	2.41	2.29	7.12	1.77	39.51
1893	2.88	6.66	6.17	4.45	4.39	2.50	2.71	5.80	1.99	2.16	2.81	5.59	48.11
1894	4.26	4.85	1.56	3.97	4.35	1.54	1.08	1.87	2.37	7.91	4.98	5.78	44.52
1895	3.02	0.87	2.71	4.79	2.73	2.04	3.58	2.05	3.13	6.89	3.95	3.85	39.61
1896	2.75	4.73	5.81	0.88	2.93	3.59	2.27	1.74	5.65	3.60	3.41	2.95	40.31
1897	4.24	2.08	2.31	4.28	3.65	2.99	2.88	2.91	1.42	0.87	6.42	3.27	37.32
1898	3.75	4.04	2.27	5.82	5.65	1.93	6.58	7.33	1.35	8.96	8.48	2.24	58.40
1899	6.52	5.23	6.77	1.18	1.40	3.62	3.79	1.17	6.92	3.03	2.28	1.60	43.51
1900	4.86	5.35	3.62	1.95	5.11	2.29	1.37	3.28	3.10	5.40	5.36	3.15	44.84
1901	2.51	1.70	6.86	7.78	8.54	1.46	4.38	2.25	2.77	2.07	2.59	10.20	53.11
1902	2.22	5.53	7.82	2.98	1.52	3.68	1.89	1.43	3.65	5.32	1.72	6.77	44.53
1903	4.43	5.36	7.94	7.45	0.67	4.76	2.44	5.44	1.45	6.32	3.22	3.98	53.46
1904	5.44	3.61	2.47	9.11	2.23	2.58	4.02	3.52	3.18	1.85	3.53	4.10	45.64
1905	4.50	2.16	2.87	2.32	1.11	8.01	1.78	2.99	6.93	1.72	2.04	4.21	40.64
1906	4.05	5.33	8.69	2.34	5.28	2.36	6.42	2.02	2.98	4.50	3.45	3.13	50.55
1907	3.92	3.41	2.31	4.08	3.68	2.70	1.10	1.82	11.16	2.91	6.82	6.90	50.81
1908	3.78	4.37	3.95	2.48	2.98	2.30	2.87	4.41	1.61	10.19	1.53	4.28	44.75
1909	5.44	6.18	3.74	6.41	3.51	3.03	1.83	2.44	4.95	2.23	8.15	3.34	51.25
1910	5.98	5.82	1.05	2.51	2.27	3.82	2.71	2.32	1.81	1.94	5.69	2.96	38.88
1911	3.17	3.45	3.38	3.68	0.77	3.05	6.84	4.66	3.44	3.60	6.59	3.58	46.21
1912	1.88	4.00	7.51	3.87	4.71	0.39	2.32	3.50	1.49	1.26	3.83	6.16	43.92
1913	4.09	3.50	3.40	6.66	2.30	1.57	1.77	3.03	3.49	11.08	2.79	1.61	48.29
Av.	4.29	4.11	4.68	4.14	3.38	2.76	3.02	3.45	3.57	4.48	4.31	4.13	46.32

RAINFALL AT PRINCETON, MASS. Elevation, 1 125 feet.

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1885	8.35	2.94	1.21	2.93	3.03	1.67	4.23	6.89	1.40	4.66	6.69	1.91	45.91
1886	5.28	5.32	3.54	2.85	3.80	1.86	4.49	3.18	3.93	2.97	5.55	4.21	46.98
1887	**5.45**	**4.57**	5.82	3.53	1.60	3.55	7.27	8.98	1.89	2.15	3.24	3.35	51.40
1888	**4.35**	**4.30**	**5.75**	2.87	4.08	3.39	2.62	5.14	6.38	5.67	6.22	5.52	56.29
1889	5.99	1.12	1.82	4.30	4.47	2.71	8.76	4.72	3.32	4.85	5.99	2.87	50.92
1890	**3.28**	2.60	**6.50**	2.28	4.58	2.02	4.38	5.90	5.57	10.04	1.48	**3.90**	52.53
1891	**7.70**	**3.60**	**5.92**	1.75	2.10	4.99	3.68	1.99	2.43	3.31	2.70	2.16	42.33
1892	**5.42**	**2.46**	**3.30**	0.64	5.08	3.04	4.20	7.33	1.63	**0.94**	...	...	....
1897	2.92	3.01	4.08	2.22	5.64	5.39	10.00	3.57	2.17	0.97	7.43	6.23	53.63
1898	5.54	2.90	2.27	4.21	3.53	3.02	2.68	9.96	3.05	7.60	6.01	4.47	55.24
1899	2.76	4.95	6.55	1.74	1.41	4.81	3.70	2.67	4.15	2.80	1.85	2.21	39.60
1900	4.64	8.59	5.47	2.58	4.65	3.28	2.86	3.75	3.73	3.40	6.32	2.90	52.17
1901	1.63	0.98	5.30	9.84	6.85	1.03	5.56	4.78	3.22	3.77	2.47	9.46	54.89
1902	3.10	4.20	4.84	4.43	2.98	3.09	3.96	3.62	4.30	6.56	0.92	7.39	49.39
1903	2.63	4.41	6.52	3.09	1.74	10 08	3.95	4.30	3.20	4.78	2.60	3.71	51.01
1904	3.25	2.70	3.67	7.27	2.93	3.51	3.83	3.91	5.68	1.95	1.57	2.61	42.88
1905	6.04	1.73	4.14	2.54	1.01	4.44	6.18	3.37	6.35	1.80	2.46	3.91	43.97
1906	2.61	2.60	5.08	3.26	6.31	5.64	5.83	5.48	2.54	3.85	2.28	4.20	49.68
1907	2.64	1.86	1.51	2.07	2.81	**3.54**	**3.03**	1.00	9.45	5.48	5.52	4.02	42.93
1908	3.11	4.66	2.27	2.56	5.25	1.28	3.52	6.77	0.84	2.01	0.89	2.79	35.95
1909	3.29	6.03	3.94	5.25	2.94	2.74	4.06	3.39	3.46	1.72	1.59	3.84	42.25
1910	5.43	4.64	1.39	3.44	3.28	4.23	1.82	3.45	2.86	1.36	4.23	2.21	38.34
1911	2.78	2.06	3.54	1.76	1.76	2.08	2.14	5.53	3.04	5.49	3.87	2.89	36.94
1912	2.46	2.18	5.52	3.92	5.94	0.70	2.56	3.34	2.39	3.00	3.83	5.10	40.94
1913	3.70	2.41	5.29	3.67	3.30	0.67	1.87	3.58	4.13	6.11	2.90	2.39	40.02
Av.	4.12	3.51	4.25	3.52	3.58	3.32	4.29	4.55	3.74	4.01	3.69	3.93	46.51

RAINFALL AT PROVINCETOWN, MASS. Elevation, 40 feet.

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1882	...	...	4.55	4.70	5.96	2.73	1.43	0.78	6.39	4.49	3.69	5.57	....
1883	4.76	5.00	2.16	3.09	3.45	1.39	4.33	0.71	1.87	7.45	3.58	2.60	40.39
1884	6.58	7.34	6.77	8.31	...	...	...	...	...	..	...	...	....
1885	...	...	...	...	...	...	...	...	...	...	...	...	....
1886	...	...	...	...	3.89	1.24	0.72	...	...	...	...	...	....
1887	...	...	...	...	...	...	...	...	...	...	...	...	....
1888	4.29	2.74	3.61	1.86	3.94	1.60	2.12	3.62	6.96	3.98	4.45	3.08	42.25
1889	3.52	4.04	2.32	3.70	4.10	1.82	4.30	6.86	2.20	4.95	4.71	2.90	45.42
1890	...	2.92	6.96	3.14	2.99	3.46	1.76	2.81	7.62	6.78	...	3.48	....
1891	6.71	4.54	3.69	3.28	1.69	2.14	2.71	3.93	2.77	5.82	1.52	3.15	41.95
1892	3.42	1.88	4.48	1.37	3.64	2.07	1.30	3.70	2.21	2.36	5.77	1.68	33.88
1893	1.63	5.37	4.79	3.27	3.08	5.50	1.71	4.37	3.03	1.59	2.47	5.58	42.39
1894	3.98	2.67	1.28	3.22	3.51	0.70	0.46	1.44	1.90	5.69	3.17	4.88	32.90
1895	3.08	1.07	3.90	3.08	3.47	...	...	...	...	...	...	...	....
1898	3.60	4.53	2.12	...	3.12	0.81	6.26	5.84	0.93	...	...	...	....
1899	...	...	4.31	0.57	1.06	4.41	4.23	0,10	4.85	...	...	0.93	....
1900	3.74	3.58	3.17	1.92	...	...	1.72	2.03	3.24	4.02	3.87	1.53	....
1901	3.24	0.67	5.40	5.34	10.49	1.79	3.82	2.37	3.35	1.24	2.41	7.62	47.74
1902	2.46	3.62	6.35	2.58	1.28	4.05	2.04	0.67	1.73	3.88	1.96	6.53	37.15
1903	4.15	3.48	6.41	4.40	0.56	3.52	2.48	3.64	1.62	5.47	4.39	3.22	43.34
1904	4.62	4.48	1.52	5.56	2.50	1.65	3.02	2.23	2.25	1.99	3.10	2.94	35.86

RAINFALL AT PROVINCETOWN, MASS. — *Continued.*

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1905	5.31	1.19	2.45	1.79	1.04	2.26	1.79	2.77	4.78	1.50	3.07	3.29	31.24
1906	3.77	3.86	6.80	1.56	4.46	3.26	3.42	1.92	2.14	3.04	2.78	3.02	40.03
1907	4.20	2.99	1.55	2.44	3.81	1.75	1.24	1.59	7.63	3.31	5.11	4.72	40.34
1908	3.09	4.55	4.53	2.12	2.60	1.92	1.75	3.41	1.21	7.47	1.65	2.83	37.13
1909	5.18	4.69	3.78	4.92	3.08	0.69	0.97	1.80	4.75	2.86	5.51	3.06	41.29
1910	6.33	3.43	1.81	3.08	2.19	3.25	1.81	4.42	1.47	2.20	3.45	2.75	36.19
1911	2.92	2.10	1.99	2.25	0.27	3.34	3.33	4.17	4.43	2.75	3.50	2.06	33.11
1912	6.44	1.97	6.01	3.96	3.87	0.93	1.87	3.06	2.45	1.59	3.00	5.20	40.35
1913	4.44	3.56	2.74	4.77	2.06	1.47	1.60	3.77	3.27	7.89	2.21	2.89	40.67
Av.*	4.22	3.34	3.68	3.23	3.08	2.26	2.31	3.02	3.10	3.85	3.39	3.70	39.18

* Twenty years.

RAINFALL AT READING, MASS. Elevation, 80 feet.
(Water Works Pumping Station.)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1899	4.00	3.26	6.48	2.56	1.33	3.36	3.15	1.91	4.67	1.35	2.95	1.50	36.52
1900	5.32	8.69	5.03	2.15	4.60	3.13	1.90	3.17	4 15	3.31	5.05	2.44	48.94
1901	1.33	1.08	5.88	9.59	7.19	1.74	4.65	2.66	3.59	2.67	3.06	8.10	51.54
1902	1.80	6.11	4.69	6.22	1.69	1.98	3.02	3.75	4.01	4.91	0.99	5 60	44.77
1903	3.84	3.16	6.38	4.95	0.48	8.91	3.40	3.42	2.29	3.69	1.33	2.59	44.44
1904	4.42	2.21	2.21	9.90	3.56	2.56	1.88	4.26	5.16	2.02	1.80	2.25	42.23
1905	5.44	1.47	2.92	2.59	1.39	6.11	1.19	3.30	7.87	1.20	2.22	3.72	39.42
1906	2.60	2.53	6.48	2.84	5.14	2.63	5.88	4.18	1.36	2.38	3.31	3.08	42.41
1907	3.97	2.10	2.04	3.21	2.89	3.80	3.58	1.33	7.90	3.36	6.83	3.60	44.61
1908	3.07	4.28	2.72	1.71	4.00	1.58	3.01	4.07	0.86	3.56	1.10	2.66	32.62
1909	4.17	5.33	3.57	3.95	1.97	2.14	3.59	2.75	3.74	1.23	4.06	3.60	40.10
1910	4.54	3.14	1.58	2.32	1.19	4.36	1.98	2.61	2.45	1.48	4.30	1.92	31.87
1911	2.25	2.94	3.31	1.89	0.60	3.90	4.79	3.80	2.94	2.91	4.14	3.57	37.01
1912	2.72	2.42	5.04	4.05	5.73	0.29	6.44	2.02	3.02	1.45	3.10	4.80	41.08
1913	2.48	2.64	4.51	3.76	3.45	0.93	1.68	3.47	3.66	7.56	2.13	3.23	39.50
Av.	3.46	3.43	4.19	4.11	3.02	3.16	3.34	3.11	3.85	2.87	3.09	3.51	41.14

RAINFALL AT ROCHESTER, MASS. Elevation, 60 feet.
(Little Quittacas Pond, New Bedford Water Works.)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1899	6.27	6.83	8.25	1.90	1.63	3.91	2.94	2.24	7.27	2.22	2.21	1.77	47.44
1900	4.96	6.10	4.25	2.27	5.59	1.41	2.28	1.76	3.05	5.46	3.95	2.70	43.78
1901	2.36	1.05	7.78	6.65	8.47	1.92	3.45	2.75	3.09	2.85	1.99	9.52	51.88
1902	2.22	5.88	6 27	3.85	1.05	4.10	2.06	1.29	3.65	4.78	1.72	5.14	42.01
1903	4.14	6.26	8.13	5.77	0.91	4.84	2.12	3.75	1.19	4.64	2.71	3.84	48.30
1904	2.83	4.04	2.42	9.28	3.40	4.38	1.68	4.38	2.66	1.86	2.36	3.34	42.63
1905	2.71	2.31	2.46	1.99	1.95	7.76	2.76	3.84	5.80	2.14	2.64	4.47	40.83
1906	3.88	4.86	7.58	2.62	5.01	3.86	4.89	1.71	3.62	3.35	2.87	3.62	47.87
1907	3.31	2.56	1.74	3.47	4.17	2.04	2.10	1.62	7.43	3.29	5.62	5.92	43.27
1908	2.54	4.35	3.74	2.14	4.22	2.07	2.36	4.94	1.47	8.04	1.41	4.46	41.74
1909	4.38	5.92	4.08	6.51	3.02	1.96	1.11	2.23	4.40	2.07	4.69	2.98	43.35
1910	2.49	5.19	1.24	2.25	3.19	4.56	2.89	2.42	1.65	2.46	4.43	3.12	35.89
1911	3.75	2.63	3.80	3.64	1.39	2.14	5.12	4 06	2.98	2.37	7.40	3.50	42.78
1912	5.32	3 74	8.11	3 67	4.13	0 28	1.14	4.88	1.96	1.40	4.27	6.62	45.52
1913	5.01	3.48	3.34	5.74	1.75	1.32	2.37	3.11	2.33	11.42	2.75	5.46	48.08
Av.	3.74	4.35	4.88	4.12	3.33	3.10	2.62	3.00	3.50	3.89	3.40	4.43	44.36

RAINFALL AT ROCKPORT, MASS. Elevation, 30 feet.

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1902	...	...	...	...	...	3.04	2.85	1.94	2.48	4.34	1.45	6.27	....
1903	3.69	3.28	6.83	3.85	0.35	7.66	2.66	2.59	3.04	2.72	1.45	3.78	41.90
1904	6.90	4.24	2.96	8.90	3.80	2.72	1.33	3.08	5.74	2.00	1.86	3.64	47.17
1905	5.51	2.49	3.28	2.93	2.27	6.78	1.86	2.99	6.61	1.51	2.98	5.29	44.50
1906	2.82	2.65	7.51	2.36	4.95	3.48	4.17	1.63	1.30	3.44	3.60	3.69	41.60
1907	3.52	2.98	1.95	3.64	2.68	2.92	3.06	1.23	8.96	2.88	5.25	4.30	43.37
1908	2.12	3.25	3.02	1.41	3.44	0.70	5.19	2.81	0.75	4.98	1.76	2.84	32.27
1909	5.54	4.38	3.50	4.50	1.99	0.96	2 35	2.03	4 95	1.71	3.43	4.17	39.51
1910	4.22	4.29	1.86	2.66	1.62	3.69	2.49	1.80	1.50	1.52	3.24	2.23	31.12
1911	2 15	2.91	3 17	2.36	0.63	2.68	9.02	3.52	2.64	2.37	4.54	3.28	39.27
1912	4.14	2.34	4.03	2.18	3.65	0.39	5.78	1.68	2.07	2.21	3.03	4.79	36.29
1913	2.09	3.58	4.39	4.73	2.98	2.02	1.92	2.09	2.64	4.81	1.55	3.33	36.13
Av.	3.88	3.31	3.87	3.59	2.58	3.09	3.62	2.32	3.65	2.74	2.97	3.76	39.38

Beginning early in 1906 a graduated glass was used in measuring the rainfall at this station. It having been found that this glass gave readings too large by about 17 per cent., each rainstorm from January, 1906, to March, 1913, has been recalculated, and between those dates the results in this table consequently do not agree with those recorded at the station. Beginning with March, 1913, a standard gage has been in use at this station.

RAINFALL AT ROWE, MASS. Elevation, 1 300 feet.

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1877	...	...	...	...	...	3.78	3.25	2.00	0.60	6.95	5.10	1.23	....
1878	5.25	3.75	3.43	6.45	1.92	5.80	6.78	3.00	2.20	3.55	6.60	5.50	54.23
1879	2.40	3.10	5.35	3.55	1.40	7.90	4.40	3.80	4.15	1.00	3.50	5.45	46.00
1880	4.75	3.75	2.40	3.80	2.70	2.48	7.55	4.60	2.15	3.30	1.48	2.72	41.68
1881	3.70	4.25	4.70	1.20	7.25	4.50	5.00	1.58	3.80	2.90	5.00	5.60	49.48
1882	3.80	4.07	3.00	1.80	4.65	2.70	2.80	2.70	9.70	0.25	0.63	1.40	37.50
1883	2.05	3.65	1.30	2.42	4.07	1.95	5.30	2.15	3.05	6.25	1.82	2.60	36.61
1884	3.27	5.10	4.65	1.85	1.55	1.60	5.10	3.22	0.95	3.02	3.70	5.03	39.04
1885	4.50	3.91	1.30	3.13	3.05	2.26	4.16	7.37	1.80	4.08	5.55	2.70	43.81
1886	4.65	1.90	4.50	2.45	4.25	3.25	4.10	2.65	4.65	3.49	6.88	4.60	47.37
1887	7.30	7.25	3.60	3.32	1.35	6.40	6.05	6.60	1.45	2.21	3.55	4.65	53.73
1888	2.20	4.95	7.00	3.70	4.00	3.27	2.05	6.50	6.25	5.50	6.30	4.35	56.07
Av.	3.99	4.15	3.75	3.06	3.29	3.83	4.85	4.02	3.65	3.23	4.09	4.05	45.96

RAINFALL AT SOMERSET, MASS. Elevation, 40 feet.

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1891	8.94	7.09	5.53	4.01	2.09	1.76	4.24	2.12	2.66	4.37	2.95	3.15	48.91
1892	4.98	1.71	4.59	1.69	4.95	2.29	2.51	2.92	3.10	1.76	5.49	1.39	37.38
1893	3.29	7.17	4.78	4.20	4.83	3.34	1.47	6.23	3.00	2.70	2.53	4.99	48.53
1894	2.88	3.98	1.29	3.23	3.97	1.63	1.68	1.81	4.12	8.21	4.70	5.08	42.58
1895	3.93	1.16	3.38	5.37	4.07	2.01	3.41	4.13	1.55	6.51	4.42	3.20	43.14
1896	2.27	6.07	5.22	1.29	2.79	5.32	2.74	2.60	7.74	2.92	3.21	3.08	45.25
1897	3.88	1.72	2.83	4.65	4.71	3.01	4.65	6.12	2.45	1.34	8.82	4.63	48.81
1898	3.38	6.11	3.35	5.68	4.77	1.04	5.78	5.60	2.73	9.29	7 62	1.99	57.34

RAINFALL AT SOMERSET, MASS. — *Continued.*

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1899	5.41	5.32	7.84	1.89	2 34	3.05	3.05	1.41	6.76	3.08	1.01	0 88	42.04
1900	4.45	6.25	5.97	1.79	5.55	1.92	2.60	3.08	4.37	4.54	4.38	2.40	47.30
1901	2.03	1.22	7.58	8.79	7.54	1.71	5.02	2.97	3.58	3.12	2.50	8.60	54.66
1902	3.40	6.03	6.44	3.55	1.04	4.55	2.19	1.28	3.58	3.88	1.88	5.83	43.65
1903	5.85	6.25	9.27	6.72	0.68	5.35	3.28	4.01	0.87	4 04	2.39	5.18	53.89
1904	4.68	3.50	3.58	10.25	2.75	4.17	1.80	3.82	3.62	1.40	2.56	4.40	46.53
1905	4.17	1.49	2.91	2.63	1.80	7.71	4.04	4.08	5.31	2.17	2.70	4.14	43.15
1906	3.10	2.79	6.02	2.61	3.93	3.79	3.39	2.89	3.08	3.64	2.79	5.47	43.50
1907	4.23	3.81	1.33	3.83	3.88	1.95	1.17	1.14	**7.89**	2.80	**5.98**	4.78	42.79
1908	3.95	4.29	5 95	2.23	3.16	2.13	3.48	5.22	0.90	5.28	1.31	3.65	41.55
1909	4.81	5.73	3.85	5.80	2.87	1.08	0.54	2.29	3.48	1.84	3.65	2.53	38.47
1910	5.62	4.42	2.64	1.32	2.94	3.80	3.05	2.80	2.29	2.24	4 27	2.85	38.24
1911	2.84	1.91	2.70	3.97	1 68	1 67	4.96	3.87	2.44	2.91	6.24	2.94	38.13
1912	3.46	2.54	6.07	3.91	4 09	0.23	0.86	3.61	1.76	0.85	3.57	5.52	36.47
1913	3.92	3.32	3.58	5.61	1.89	1.28	2.85	2.65	2.80	9.20	1.99	3.45	42.54
Av.	4.15	4.08	4.64	4.13	3.41	2.82	2.99	3.33	3.48	3.83	3.78	3.92	44.56

RAINFALL AT SOMERVILLE, MASS. Elevation, 60 feet.

(Old Mystic Pumping Station, Boston Water Works.)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1876	1.60	3.68	6.99	3.72	2.23	1.58	8.17	0.90	4.65	1.98	6.86	2.28	44.64
1877	3.39	0.71	7.35	3.23	3.47	1.85	2.34	5.69	0.28	7.15	7.39	0.78	43.93
1878	5.79	6.00	3.81	5.57	0.78	2.57	3.85	8.53	2.47	4.91	5.73	4.87	54.88
1879	2.05	2.74	3.50	5.02	1.99	4.66	2.69	5.37	1.73	0.68	2.75	3.75	36.93
1880	2.59	4.38	2.57	1.96	1.90	0.89	7.21	3.60	1.50	2.65	1.97	2.31	33.53
1881	5.63	3.74	5.87	1.60	2.87	6.43	3.06	0.65	4.07	2.19	3.86	3.30	43.27
1882	4.95	3.62	2.63	2.05	4.33	2.51	1.81	1.28	9.10	1.93	1.09	2.09	37.39
1883	2.91	2 97	1.76	2.24	3.58	1.56	2.63	0.51	1.44	5.38	1.99	2.54	29.51
1884	4.70	6.24	4.35	3.51	2.83	4.37	3.89	4.79	0.79	2.66	2.49	4.37	44.99
1885	4.83	3.44	1.08	3.48	3.28	3.82	1.98	5.23	1.53	5.42	6.00	1.85	41.94
1886	6.61	6.51	3.27	1.47	2.68	1.48	4.01	2.62	2.81	2.58	3.89	4.82	42.75
1887	4.66	4.13	4.60	4.02	1.42	1.91	4.62	4.07	1.26	3.03	2.92	3.51	40.15
1888	3.65	3.50	4.95	2.67	5.10	2.22	2.27	7.24	8.33	4.87	6.47	5.26	56.53
1889	5.57	1.80	2.25	3.65	4.64	3.43	8.58	3.62	4.86	3.88	5.88	2.83	50.99
1890	2.47	3.25	6.49	2.43	5.83	3.32	2.02	3.35	3.85	9.00	1.36	4.27	47.64
1891	5.99	4.85	5.68	2.85	2.31	4.09	3.29	3.72	2.67	5.05	2.50	3.45	46.45
1892	4.50	2.60	4.06	0.92	5.64	3.87	2.53	4.88	1.88	1.94	4.82	1.26	38.90
1893	1.97	7.71	2.54	3.42	6.10	2.07	2.07	5.36	1.92	4.11	2.21	4.21	43.69
1894	3.79	3.09	0.99	2.64	4.74	0.52	3.13	1.75	3.04	5.38	3.46	4.46	36.99
1895	3.62	0.75	2.85	4.28	2.54	3.14	4 04	5.29	1.53	9.27	7.47	2.17	46.95
1896	2.72	5.08	5.12	2.00	1.85	2.32	2.53	2.81	7.07	3.11	3.62	2.36	40.59
1897	3.41	2.56	3.18	3.10	4.84	5.74	3.17	4.05	3.16	0.44	6.90	4.79	45.34
Av.	3.97	3.79	3.90	2.99	3.41	2.92	3.63	3.88	3.18	4.00	4.17	3.25	43.09

RAINFALL AT SOUTHBORO, MASS. Elevation, 260 feet.

(Sudbury Dam No. 5, Metropolitan Water Works.)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1899	4.05	4.81	6.56	1.95	1.41	2.40	2.94	1.26	3.75	2.53	2.10	1.70	35.46
1900	5.03	8.84	6.32	2.59	4.28	2.75	2.68	2.11	3.25	3.72	5.58	2.50	49.65
1901	1.81	1.35	6.34	8.19	7.74	1.37	5.08	4.10	2.91	3.04	2.70	8.29	52.92
1902	2.45	6.01	4.71	3.84	1.93	2.91	3.04	3.72	4.40	4.37	1.44	5.80	44.62
1903	3.65	3.85	6.37	2.87	0.95	10.41	2.69	3.44	1.89	4.84	1.50	2.84	45.30
1904	4.64	2.86	2.57	8.38	2.84	3.36	2.24	4.32	4.80	1.58	1.68	2.80	42.07
1905	5.20	2.58	3.27	2.80	1.29	4.87	6.31	2.63	6.08	1.46	1.93	3.85	42.27
1906	2.33	2.78	6.12	2.80	5.40	3.87	3.45	2.43	2.90	3.12	2.48	4.36	42.04
1907	3.14	2.17	1.81	3.51	3.60	3.46	1.56	1.09	8.97	4.27	5.53	4.30	43.41
1908	3.52	4.13	3.50	1.82	5.11	0.79	3.73	4.24	0.92	2.52	1.00	3.03	34.31
1909	3.92	5.63	4.18	4.60	2.32	2.60	1.77	2.82	4.92	1.01	3.41	4.04	41.22
1910	5.28	4.98	0.89	2.83	1.26	4.11	1.88	2.24	2.16	1.87	3.90	2.39	33.79
1911	2.78	2.78	3.50	2.49	0.72	2.47	3.35	4.26	2.46	3.70	4.59	3.32	36.42
1912	2.77	2.88	6.04	4.19	4.71	0.28	2.64	3.24	1.80	2.01	3.58	4.94	39.08
1913	2.93	2.79	5.43	4.19	3.99	1.57	3.80	3.24	3.50	5.31	2.42	3.06	42.23
Av.	3.57	3.90	4.51	3.80	3.17	3.15	3.14	3.01	3.65	3.02	2.92	3.81	41.65

RAINFALL AT SOUTHBORO, MASS. Elevation, 250 feet.

(Cordaville, Metropolitan Water Works.)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1894	3.75	3.98	1.49	3.86	4.78	2.14	3.14	2.75	2.49	5.76	3.58	4.55	42.27
1895	4.06	1.77	2.95	5.33	2.19	3.10	4.63	4.38	2.27	9.38	7.47	3.48	51.01
1896	2.47	6.12	5.07	1.42	2.67	3.45	2.39	2.39	6.71	3.88	3.29	1.94	41.80
1897	3.93	2.93	4.30	2.76	4.43	5.64	4.10	3.96	3.15	0.36	6.77	5.78	48.11
1898	7.27	4.72	2.55	4.86	3.29	2.96	3.76	9.02	3.25	6.55	6.58	3.44	58.25
1899	4.18	5.04	7.27	2.10	1.29	2.81	3.60	1.39	4.12	2.79	2.54	2.03	39.16
1900	5.24	9.78	6.67	2.83	4.72	3.01	2.25	2.21	3.48	4.18	5.90	3.10	53.37
1901	1.65	1.51	6.80	9.87	7.43	1.56	6.19	4.93	3.73	3.04	3.26	9.31	59.28
1902	2.56	5.72	5.48	4.26	2.09	3.00	2.68	3.04	5.44	4.86	1.59	6.78	47.50
1903	3.96	4.02	7.25	3.24	0.94	9.98	2.96	3.96	2.17	4.85	1.63	3.46	48.42
1904	5.52	3.08	2.85	9.31	2.60	2.86	1.89	3.92	6.69	1.78	1.80	2.81	45.11
1905	5.27	2.08	3.01	2.95	1.28	5.64	5.38	2.94	7.31	1.79	2.33	4.24	44.22
1906	2.59	3.07	6.56	3.25	6.33	4.63	3.63	3.77	3.99	3.85	3.12	4.68	49.47
1907	3.43	2.21	2.19	3.67	3.87	4.56	2.12	1.07	9.68	4.51	7.05	4.82	49.18
1908	4.21	5.28	4.26	2.14	5.56	1.02	4.18	5.39	1.12	2.63	1.12	3.53	40.44
1909	3.86	6.03	4.47	4.95	2.73	2.53	1.74	3.35	4.91	1.25	3.50	4.21	43.53
1910	5.87	5.20	0.84	2.82	1.40	4.75	2.11	3.11	2.63	1.96	4.57	2.51	37.77
1911	3.19	2.92	3.96	3.01	1.55	2.84	3.21	5.68	3.12	4.05	4.89	3.80	42.22
1912	3.18	2.91	6.82	4.89	4.64	0.67	3.13	3.40	1.98	2.50	4.11	5.56	43.79
1913	3.40	2.95	6.04	4.51	4.16	2.17	4.37	3.28	4.13	6.17	3.09	3.36	47.63
Av.	3.98	4.07	4.54	4.10	3.40	3.47	3.37	3.70	4.12	3.80	3.91	4.17	46.63

RAINFALL AT SOUTHAMPTON, MASS. Elevation, 525 feet.

(Fomer Reservoir, Holyoke Water Works.)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1897	4.29	2.89	3.27	2.41	4.05	7.16	13.96	6.32	1.24	1.25	5.99	6.57	59.40
1898	5.82	4.47	2.49	4.20	6.16	4.17	3.95	7.28	3.35	7.40	5.92	3.73	58.94
1899	3.05	3.36	6.81	1.92	1.31	2.43	5.07	1.94	5.01	1.31	3.16	2.86	38.23
1900	3.59	10.28	5.54	1.84	4.44	1.78	2.49	3.91	2.00	3.32	4.31	3.27	46.77
1901	2.11	0.78	6.29	10.98	9.93	1.96	2.59	6.15	4.76	4.77	1.54	4.79	56.65
1902	3.32	4.66	6.38	4.45	2.08	2.85	5.75	4.63	5.34	6.99	1.62	7.46	55.53
1903	1.88	5.30	5.57	3.63	0.89	14.33	3.80	7.82	2.38	3.92	1.70	6.28	57.50
1904	3.60	2.61	4.33	6.87	4.22	6.73	3.01	5.07	4.73	3.56	1.00	2.96	48.69
1905	4.75	1.72	3.69	2.70	0.99	2.99	5.96	5.54	8.89	2.94	1.86	4.16	46.19
1906	2.64	2.43	4.45	5.37	5.45	3.34	6.51	2.59	2.99	2.80	3.01	3.66	45.24
1907	2.92	1.62	1.96	2.49	3.77	4.54	2.85	1.73	11.58	6.70	6.59	4.91	51.66
1908	3.41	4.84	3.44	3.19	7.19	1.70	4.40	4.10	1.85	2.62	1.02	2.91	40.67
1909	4.33	6.41	5.30	6.45	4.00	3.12	1.16	4.70	4.36	1.32	2.34	3.64	47.13
1910	7.97	6.88	1.60	5.36	3.52	3.70	1.67	4.48	2.25	0.72	5.59	1.87	45.61
1911	1.95	1.78	4.20	2.62	0.84	4.06	4.43	6.71	4.55	8.84	2.58	2.54	45.10
1912	4.71	3.12	5.39	3.28	4.58	0.80	2.43	4.96	3.38	5.69	4.24	4.70	47.28
1913	3.61	2.32	5.78	3.95	5.19	0.67	1.88	2.37	3.44	6.77	3.74	3.06	42.78
Av.	3.76	3.85	4.50	4.22	4.04	3.90	4.23	4.72	4.24	4.17	3.31	4.08	49.02

RAINFALL AT SPRINGFIELD, MASS. Elevation, 105 feet.

(City Engineer's Office.)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1892	3.58	1.09	1.32	0.56	5.87	4.08	6.88	5.83	1.67	0.91	5.27	0.64	37.70
1893	2.81	4.33	3.47	3.94	4.97	3.41	1.76	2.87	2.38	4.73	1.63	3.42	39.72
1894	0.93	1.36	1.39	1.21	3.10	1.95	2.18	0.70	4.42	4.32	3.36	2.51	27.43
1895	3.02	0.27	2.06	3.96	1.63	2.94	4.20	3.30	2.89	5.45	4.02	2.92	36.66
1896	0.33	4.15	5.26	0.98	2.15	2.83	5.30	2.34	6.37	3.45	2.12	1.05	36.33
1897	2.57	2.02	2.90	2.35	4.02	5.78	14.68	4.21	1.51	1.65	6.15	5.51	53.35
1898	5.16	4.10	1.81	3.11	4.37	3.13	4.54	6.38	2.61	5.54	6.61	1.82	49.18
1899	2.85	2.05	5.44	2.52	2.08	4.02	5.39	1.25	3.12	2.73	2.03	1.30	34.78
1900	3.00	7.63	5.06	1.43	4.72	2.90	2.38	1.91	2.36	3.23	6.25	2.75	43.62
1901	1.28	0.39	5.27	7.03	6.83	1.62	4.75	8.24	3.41	4.10	1.41	8.16	52.49
1902	1.37	3.09	4.84	3.70	1.33	2.86	4.55	6.70	6.72	5.28	0.86	5.44	46.74
1903	3.29	3.84	5.08	1.74	0.83	8.33	4.68	6.13	2.73	2.27	2.63	2.36	43.91
1904	2.20	2.29	3.83	5.23	2.14	2.11	3.02	7.22	6.01	2.17	1.13	1.77	39.12
1905	2.61	1.08	3.01	2.19	1.11	3.16	2.03	3.86	6.89	1.73	1.91	3.25	32.83
1906	2.33	1.94	3.86	3.44	4.89	4.20	4.12	3.05	3.31	6.15	2.10	2.74	42.13
1907	3.64	1.26	4.39	2.00	3.77	3.60	1.76	1.39	8.27	5.36	4.34	3.59	43.37
1908	3.25	4.14	2.58	1.61	5.15	2.50	3.80	6.99	0.83	2.62	0.72	1.89	36.08
1909	2.61	5.14	2.62	6.43	2.63	1.33	1.49	3.87	3.96	1.30	1.85	1.75	34.98
1910	4.37	3.26	1.40	3.25	2.21	3.06	2.07	3.20	3.42	0.66	3.49	1.79	32.18
1911	2.15	1.57	3.40	2.03	1.37	2.47	3.81	6.76	3.94	8.66	3.35	2.33	41.84
1912	0.95	2.80	5.18	4.59	4.40	0.39	1.89	3.76	2.33	2.56	3.78	3.51	36.44
1913	2.99	1.66	4.53	2.95	3.55	0.81	1.36	3.27	2.34	5.69	1.81	1.90	32.86
Av.	2.60	2.70	3.59	3.01	3.32	3.07	3.94	4.24	3.71	3.66	3.04	2.84	39.72

RAINFALL AT SPRINGFIELD, MASS. Elevation, 200 feet.

(1848–1867, by citizen of Springfield; 1868–1913, at United States Arsenal.)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1848	2.01	2.08	3.06	1.77	8.34	4.64	3.61	2.11	1.92	3.28	3.99	4.57	41.38
1849	0.68	0.52	3.91	1.26	4.68	2.06	3.19	4.60	1.36	7.50	2.56	2.04	34.36
1850	4.18	3.67	2.94	4.29	8.21	3.55	5.28	5.94	5.78	4.03	2.11	3.82	53.80
1851	1.61	4.94	1.32	3.89	4.10	3.54	3.95	5.57	1.73	6.96	4.84	2.77	45.22
1852	1.88	3.12	2.54	4.37	2.88	2.46	2.96	6.47	1.77	2.59	5.45	3.95	40.44
1853	1.46	5.75	2.33	3.46	4.88	1.89	6.43	8.34	5.78	4.34	4.88	1.82	51.36
1854	2.77	4.87	2.28	7.79	4.10	1.85	7.47	0.88	4.54	2.44	8.13	3.25	50.37
1855	4.00	3.04	0.95	3.11	1.91	4.15	8.18	2.40	0.74	9.46	3.87	5.40	47.21
1856	3.11	0.75	1.04	3.02	5.23	1.70	1.69	11.72	2.57	1.40	2.26	4.13	38.62
1857	3.21	1.98	2.32	5.15	5.76	2.27	6.24	3.49	3.31	4.17	1.55	5.21	44.66
1858	3.21	1.68	0.88	3.48	2.99	5.50	3.97	3.74	4.02	3.12	1.92	3.29	37.80
1859	5.33	3.56	6.39	2.86	4.65	6.38	2.28	4.01	4.11	1.91	2.68	4.45	48.61
1860	1.60	2.71	2.50	1.49	2.62	4.12	5.32	4.98	4.93	2.60	4.30	4.19	41.36
1861	4.57	3.05	3.25	5.76	4.42	3.31	3.94	5.35	3.36	5.19	3.87	2.05	48.12
1862	5.65	2.59	4.43	2.24	2.93	10.04	6.54	3.25	1.83	2.76	4.75	2.95	49.96
1863	4.70	4.19	6.12	2.25	3.20	1.70	9.77	3.35	2.44	4.23	5.32	4.43	51.70
1864	2.51	1.22	2.25	2.54	2.87	0.56	1.22	2.54	2.61	2.97	5.16	4.45	30.90
1865	3.23	2.47	5.07	2.72	8.39	3.74	3.86	1.67	0.65	4.57	2.64	3.12	42.13
1866	1.52	4.86	2.93	2.23	5.86	5.08	3.00	2.83	5.21	2.76	3.24	3.30	42.82
1867	1.83	4.57	4.07	3.16	5.06	4.33	5.29	10.05	2.59	3.55	3.29	1.77	49.56
1868	3.65	1.66	3.79	4.53	8.90	3.46	2.95	3.27	9.96	1.62	4.87	1.42	50.08
1869	3.31	4.48	5.75	1.80	5.91	5.88	2.67	1.40	4.17	13.50	3.30	5.80	57.97
1870	5.80	5.54	3.35	3.90	1.86	3.54	3.27	1.77	2.34	4.62	3.03	1.89	40.91
1871	2.87	2.84	5.63	3.12	4.28	6.55	2.21	8.29	1.32	6.26	3.71	2.66	49.74
1872	1.51	2.50	3.35	2.20	3.16	3.37	6.20	7.13	4.34	3.87	4.92	3.41	45.96
1873	5.28	2.89	2.91	2.55	4.86	0.66	3.46	4.41	4.33	7.03	4.01	4.64	47.03
1874	5.23	3.35	1.60	6.44	4.90	3.87	5.83	4.23	2.31	2.23	2.96	1.47	44.42
1875	2.83	4.04	4.78	3.62	2.24	3.54	3.23	9.92	2.40	4.06	4.86	1.46	46.98
1876	2.10	5.65	8.47	3.12	3.31	2.63	4.59	1.40	4.75	1.21	3.48	1.64	45.35
1877	3.24	0.80	8.12	2.95	1.11	3.39	4.34	2.33	0.78	8.39	5.95	1.06	42.46
1878	4.29	4.30	3.82	6.72	2.48	7.97	2.32	3.91	2.31	2.65	5.64	5.98	52.39
1879	1.79	4.06	5.14	4.93	2.49	6.68	4.50	7.15	2.93	1.42	2.19	5.00	48.28
1880	3.93	4.04	3.14	3.64	1.94	2.02	6.44	3.17	2.74	4.07	3.45	2.07	40.65
1881	4.57	4.15	3.35	1.73	4.68	6.21	3.10	3.10	0.79	3.62	4.98	5.23	45.51
1882	5.38	4.76	3.34	1.41	5.89	4.00	1.89	1.59	11.40	1.83	0.80	2.12	44.41
1883	2.60	4.76	2.70	2.25	5.07	3.30	3.94	2.00	3.34	5.36	1.24	3.66	40.22
1884	4.77	6.23	5.22	3.10	2.60	4.72	5.27	6.12	1.81	2.76	3.48	5.20	51.28
1885	4.65	3.52	1.82	3.31	2.55	2.05	4.09	7.47	1.01	4.89	5.91	4.39	45.66
1886	5.31	4.80	3.76	2.56	3.30	1.74	4.27	3.31	4.45	3.43	4.77	3.76	45.46
1887	4.85	5.23	4.19	3.43	1.02	6.44	6.61	7.69	1.84	1.96	3.21	3.81	50.28
1888	4.22	4.07	6.48	2.49	4.28	5.97	3.06	4.03	9.00	5.50	4.08	4.84	58.02
1889	3.88	1.69	1.57	2.28	4.28	3.72	8.85	2.39	4.30	4.67	5.66	3.11	46.40
1890	2.68	4.07	6.31	2.21	5.36	1.83	4.69	5.57	11.12	6.70	1.11	3.15	54.80
1891	7.86	4.34	3.60	2.55	2.18	3.50	6.37	4.01	1.41	3.39	3.00	4.80	47.01
1892	4.99	2.09	2.29	0.64	6.96	4.43	7.17	6.58	1.89	0.97	6.14	1.14	45.29
1893	3.49	5.94	3.70	4.49	5.48	3.69	2.07	3.12	2.53	5.16	2.08	4.04	45.79
1894	2.30	2.13	1.87	1.93	3.59	2.06	2.52	0.93	5.31	4.98	4.23	3.50	35.35
1895	3.69	1.29	2.24	3.93	1.91	3.26	4.56	3.70	3.11	6.20	4.59	2.77	41.25
1896	0.76	4.45	6.78	0.85	2.57	2.87	5.74	2.58	6.24	4.03	2.90	1.37	41.14
1897	3.99	2.69	3.07	2.24	4.70	6.22	14.99	4.07	1.52	1.64	5.15	5.16	55.44

RAINFALL AT SPRINGFIELD, MASS. — *Continued.*

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1898	4.42	4.45	1.00	3.46	5.50	3.26	4.54	6.52	2.73	6.09	6.93	3.05	51 95
1899	3.20	4.42	6.80	2.37	1.78	4.03	5.37	1.30	3.33	2.93	1.96	1.67	39.16
1900	3.60	8.69	5.85	1.25	5.07	2.84	2.44	1.62	2.52	3 60	5.86	2.76	46.10
1901	1.74	0 63	5.92	6.80	5.26	1.23	5.11	7.74	3.10	4.31	1.37	8.82	52.03
1902	1.33	4 00	4.74	3.42	1.40	2.76	3.90	4.62	5.41	5.75	0.70	6.55	44.58
1903	2.80	3.91	5.53	2.47	0.78	8.01	4.55	6.96	2.58	2.27	2.55	2.61	45.02
1904	2.77	2.01	3.59	5.89	2.14	1.88	2.68	6.99	5.97	1.96	1.07	2.41	39.36
1905	2.83	1.10	2.86	1.86	1.40	2.78	0.85	3.87	6.68	1.47	1.96	3.36	31.02
1906	1.88	2.87	5 22	3.32	4.25	5.15	3.45	2.49	3.02	6.30	2.32	3.93	44.20
1907	2.82	4.48	1.21	4.38	3.33	3.26	1.57	1.25	8.28	5.28	4.61	4.12	44.59
1908	3.25	8.30	2.26	0.79	5 52	2.40	3.99	6.70	0.74	2.41	0.69	2.17	39.22
1909	2.51	5.89	3.09	7.10	3.57	1.45	1.38	4.58	4.74	1.46	2.34	1.45	39.56
1910	5.07	3.73	1.35	3.57	2.26	3.50	2.34	3.15	3.32	0.90	4.13	1.72	35.04
1911	2.60	1.46	2.04	1.60	1.27	2.81	3.97	7.14	3.89	8.91	3.73	2.81	42.23
1912	1.22	2.11	4.53	4.78	3.87	0.36	1.83	2.32	2.14	2.02	3.06	2.93	31.17
1913	1.94	1.84	5.39	2.60	4 50	0.70	1.21	2.66	2.41	6.28	2.21	2.77	34.51
Av.	3.32	3.54	3.70	3.23	3.92	3.62	4.31	4.39	3.60	4.09	3.61	3.45	44.78

RAINFALL AT STERLING, MASS. Elevation, 500 feet.
(Metropolitan Water Works.)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1897	3.59	2.53	3.81	2.24	5.18	5.25	9.06	3.66	1.66	0.87	7.58	6.31	51.74
1898	6.96	2.94	1.88	4.59	3.29	3.11	2.78	9.88	3.18	7.20	6.24	3.60	55.65
1899	2.78	5.26	6.71	1.80	0.99	4.39	3.43	3.54	3.82	2.59	1.85	1.70	38.86
1900	4.19	8.76	6.22	2.33	4.26	3.84	2.61	2.90	3 47	2.98	6.21	3.17	50.94
1901	1.52	0.96	5.79	10.03	6.86	1.65	5.51	3.99	2.90	3.34	2 07	8.84	53.46
1902	2.30	4.72	5.12	4.37	2.61	2.51	4.16	3.01	3.72	6.38	0.76	7.00	46.66
1903	2.66	4.39	6.37	3 05	0.97	10.56	3.27	3.34	2.62	4.38	2.16	3.84	47.61
1904	3.50	2.43	3.22	6.93	3.02	3.54	3.14	3.59	5.22	1.70	1.61	2.87	40 77
1905	6.43	1.65	3.74	2.62	0.81	4 17	5.49	2.75	6 78	1.63	2.22	3.40	41.69
1906	2.33	2.50	4.60	2.63	6.27	5.98	4.31	4.54	2.34	4.03	2.01	4.37	45.94
1907	2.71	2.79	1.85	2.23	2.78	3.49	3.53	1.05	8.74	5.62	5 43	4.01	44.23
1908	3.20	4.88	2.59	2.52	5.10	1.39	3.78	5.78	0.91	1.96	0.97	3.15	36.23
1909	3.21	5.86	4.35	4.84	2.44	3.05	3.59	3.32	3.30	1.86	1.23	4.09	41.14
1910	5.29	5.62	0.81	2.77	4.68	4.83	1.59	3.91	2.66	1.51	4.16	1.98	36.81
1911	2.72	2.29	3.60	2.12	1.26	2.40	2.12	5.27	3.00	5.22	4.41	3.01	37.42
1912	2.20	2.28	5.63	3.69	6.15	0.36	2.43	2.82	1.98	2.41	3.96	4.69	38.60
1913	3.01	2.54	5.56	3.90	3.59	0.62	1.74	3.10	3.77	5.51	2.35	2.26	37.95
Av.	3.45	3.67	4.22	3.68	3.37	3.60	3.68	3.91	3.53	3.48	3.25	4.02	43.86

RAINFALL AT STONEHAM, MASS. Elevation, 160 feet.
(Spot Pond, Metropolitan Water Works.)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1899	4.10	5.27	7.17	1.40	1.03	2.90	2.67	3.22	4 81	2.76	2.49	1.42	39.24
1900	4.95	7.44	4.81	1.96	4.98	2.26	1.87	2.18	3.58	3.50	4.59	2.29	44.41
1901	1.73	0.82	6.83	8.36	7.19	1.86	4 69	3.64	3.67	2.54	2.78	7.96	52.07
1902	2.22	7.56	4 90	4.70	1.15	2.33	2 76	3 80	3.44	4.72	1.33	5 86	44.77
1903	3.78	4.58	6 38	4.67	0.33	9 16	3 32	3 41	1 41	3.84	1.40	3.18	45.52

RAINFALL AT STONEHAM, MASS. — *Continued.*

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1904	5.74	3.08	2.99	9.42	3.98	3.56	1.51	3.47	5.38	1.89	1.75	2.34	45.11
1905	5.61	1.91	3.28	2.54	1.39	5.71	1.01	3.66	7.61	1.41	2.63	3.96	40.75
1906	2.63	2.37	6.46	1.97	5.28	4.61	3.69	2.36	2.26	2.65	3.04	4.54	41.86
1907	2.90	2.19	2.43	3.31	3.06	3.71	1.91	1.33	8.88	2.98	6.76	3.88	43.34
1908	3.48	4 27	3.26	2.41	3.81	0.78	3.40	3.97	0.62	3.66	1.04	2.65	33.35
1909	4.04	5.31	3.80	4.23	1.96	4.27	2.27	3.53	5.12	1.28	4 31	3.95	44.07
1910	4.80	4.84	1.02	2.68	1.32	4.59	1.47	1.19	2.38	1.13	3.71	2.28	31.41
1911	2.78	3.18	3.47	2.45	1.01	3.69	6.30	4.52	3.34	2.93	4.02	3.72	41.41
1912	3.13	2.50	4.98	3.71	5.10	0.35	5.27	2.13	2.58	1.69	2.94	4.89	39.27
1913	3.49	2.59	4.80	4.31	3.83	1.55	3.88	3.39	2.96	6.83	2.45	3.10	43.18
Av.	3.69	3.86	4.44	3.87	3.03	3.42	3.07	3.06	3.87	2.92	3.02	3.73	41.98

RAINFALL AT STOW, MASS. Elevation, 250 feet.

(Jonathan Newell, A.M.)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1792	...	...	...	...	...	...	...	...	...	...	...	...	33.91
1793	...	...	...	...	...	...	...	...	...	...	...	...	33.58
1794	...	...	...	...	...	...	...	...	...	...	...	...	34.98
1795	3.06	2.12	3.60	7.43	4.71	3.08	5.79	4.83	4.92	4.34	1.74	2.76	48.38
1796	3.11	2.26	2.41	1.04	5.93	1.48	5.26	2.10	5.58	1.67	1.03	2.60	34.47
1797	1.07	3.80	4.56	4.46	3.33	1.90	1.70	3.95	1.85	5.97	3.10	1.84	37.53
1798	2.08	2.00	3.76	2.52	3.90	3.74	2.53	1.28	2.71	7.30	2.37	2.31	36.50
1799	1.90	2.16	4.33	3.10	3.60	8.18	2.70	1.27	2.80	1.85	2.56	2.83	37.28
1800	0.86	3.10	2.20	5.16	3.96	2.04	2.71	4.51	4.70	5.05	2.88	3.69	40.86
1801	3.96	2.49	8.27	2.50	4.32	2.59	4.05	2.53	1.11	0.91	3.32	2.81	38.86
1802	2.70	0.98	5.41	0.74	6.27	2.62	3.06	7.72	4.15	3.58	1.02	3.70	41.95
1803	2.88	5.20	2.67	2.06	2.16	0.88	8.09	1.76	1.25	3.82	2.14	4.30	37.21
1804	3.34	3.72	2.58	6.24	2.30	3.34	2.58	1.99	2.22	6.17	3.11	3.46	41.05
Av.	2.50	2.78	3.98	3.53	4.05	2.98	3.85	3.19	3.13	4.07	2.32	3.03	39.41

RAINFALL AT STURBRIDGE, MASS. Elevation, 600 feet.

(Fiskdale.)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1888	2.61	3.08	5.96	2.11	4.29	2.97	2.54	4.47	6.81	4.84	3.82	6.19	49.69
1889	3.53	1.98	1.85	2.45	2.31	3.02	8.72	2.98	2.49	5.40	4.88	2.63	42.24
1890	2.17	3.75	5.22	2.14	5.64	2.23	3.14	5.71	4.85	7.40	0.90	2.40	45.55
1891	6.31	3.41	2.86	2.14	2.23	3.07	4.20	4.47	2.83	3.66	2.67	4.62	42.47
1892	4.71	1.07	1.90	0.39	5.57	2.86	5.97	5.79	1.56	1.03	5.00	0.71	36.56
1893	2.21	4.60	2.78	2.47	5.52	2.73	1.44	3.85	1.88	4.94	2.02	3.95	38.39
1894	1.58	1.89	1.30	2.63	3.75	0.53	1.85	1.92	2.47	2.83	3.08	1.92	25.75
1895	2.89	0.76	2.17	3.96	1.70	4.03	5.15	4.80	2.70	7.21	4.74	4.01	44.12
1896	1.00	6.32	3.57	0.87	2.08	2.06	2.76	2.01	7.26	3.39	2.34	1.23	34.89
1897	2.34	2.05	2.25	2.88	3.75	3.67	9.41	3.08	1.36	0.64	6.71	4.78	42.92
1898	3.49	3.80	3.35	2.89	2.98	2.70	6.97	7.28	3.42	6.32	5.44	2.99	51.63
1899	2.37	3.71	5.21	2.02	1.34	4.17	...	1.97	3.81	2.31	1.30	...	....
1900	...	7.75	6.31	...	4.61	4.22	...	...	2.43	4.13	...	...	....
Av.	2.99	2.97	3.02	2.27	3.62	2.72	4.74	4.21	3.42	4.33	3.78	3.22	41.29

RAINFALL AT TAUNTON, MASS. Elevation, 50 feet.

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1875	7.64	4.21	3.75	5.40	2.90	2.48	3.37	4.63	1.69	2.62	2.96	1.67	43.32
1876	5.06	4.68	3.39	3.88	1.91	1.82	5.57	2.44	4.59	0.44	7.00	2.87	43.65
1877	4.86	2.68	3.06	1.56	2.50	2.61	2.80	5.79	0.82	8.38	6.88	3.84	45.78
1878	5.16	4.04	3.28	5.32	1.63	2.54	2.07	1.38	1.05	4.42	7.91	5.69	44.49
1879	4.07	2.37	4.29	6.16	2.70	0.44	5.71	4.68	3.21	0.80	2.92	3.63	40.98
1880	2.37	3.33	4.44	3.89	1.19	1.77	7.33	11.74	2.16	4.17	3.19	3.91	49.49
1881	6.81	5.64	5.57	1.80	3.49	8.75	2.20	0.91	2.58	3.30	6.11	3.30	50.46
1882	4.85	5.84	3.55	3.90	4.72	2.27	1.74	0.43	8.02	3.70	1.84	3.06	43.92
1883	4.67	4.42	2.24	2.50	3.43	1.94	3.29	0.88	2.05	5.27	2.91	3.00	36.60
1884	6.18	5.43	5.33	4.36	3.08	4.34	4.28	5.40	0.62	3.30	3.89	6.01	52.22
1885	5.96	2.71	1.34	2.95	3.84	3.19	2.34	3.58	1.11	3.89	3.52	2.29	36.72
1886	7.79	9.66	4.25	2.36	4.27	1.22	3.23	4.12	3.29	3.74	5.15	6.27	55.35
1887	7.43	4.52	5.17	5.32	2.70	4.08	6.20	5.17	1.84	3.08	2.37	4.05	51.93
1888	3.82	3.79	6.37	2.24	4.72	1.61	3.55	5.03	9 14	4.79	8.88	3.86	57.80
1889	6.43	2.21	2.08	4.34	5.67	2.02	7.92	7.34	3.32	4.34	6.59	2.68	54.94
1890	2.89	3.70	8.40	3.81	5.60	3.60	1.44	3.86	5.41	10.44	0.99	4.28	54.42
1891	8.51	5.82	5.95	4.05	2.56	2.13	2.85	3.89	2.51	5.13	3.39	4.27	51.06
1892	4 93	2.41	6.66	1.46	5.93	3 81	1.72	2.98	2.76	1.56	6.55	1.71	42.48
1893	4.10	9.86	7.38	3.83	5.53	2.17	2.22	6.23	2.37	2.90	2.97	6.72	56.28
1894	4.31	7.18	1.42	4.20	4.32	0.77	2.41	1.55	3.98	8.93	6.21	5.62	50.90
1895	4.24	1.21	3.74	5.55	3.95	2.17	3.56	3.77	2.13	6.61	5.73	3.17	45.83
1896	3.08	5.67	5.79	1.30	3.22	4.21	1.53	3.37	9.21	3.36	3.87	3.30	47.91
1897	4.23	3.00	2.94	4.28	4.97	3.25	5.69	4.15	2.90	1.13	8.16	4.58	49.28
1898	6.14	6.07	3.06	7.00	4.79	1.55	9.89	5.07	3.04	10.48	7.51	2 63	67.23
1899	5.44	6.09	7.10	2.06	2.17	4.07	4.44	1.79	9.05	3.50	1.66	1.47	48.84
1900	5.21	7.56	5.42	2.16	6.87	2.67	3.06	2.43	5.08	3.97	4.91	2.91	52.25
1901	2.84	1.16	8.92	8.05	7.70	2.27	3.94	3.40	3.43	2.64	2.51	9.76	56.62
1902	2.10	6.77	5.72	3.52	1.41	4.87	2.10	2.85	3.17	3.68	1.76	5.56	43.51
1903	4.22	6.69	6.79	4 65	0.35	4.49	3.89	4.05	0.72	3.97	1.68	3.70	45.20
1904	4.49	2.65	2.47	8.54	2.50	3.37	2.45	4.95	3.45	1.72	2.05	3.25	41.89
1905	4.05	1.84	2.53	2.98	1.22	7 82	2.65	2.90	4.79	1.83	2.26	4 02	38.89
1906	2.81	4.16	6.85	2.33	4.34	3.58	4.61	1.60	2.79	4.30	2.38	4.32	44.07
1907	3.37	3.12	2.06	3.73	4.15	2.40	1.48	1.17	9.37	3.51	6.87	6.01	47.24
1908	3.69	4.33	4.12	2.78	3.45	2.32	4.05	4.67	1.17	5.62	1.32	4.50	42.02
1909	4.91	6.35	4.67	6.89	2.69	2.03	2.16	3.43	4.90	1.73	4.12	3.89	47.77
1910	7.09	4.53	1.74	1.69	3.00	4.08	2.17	2.30	2.04	1.76	4.78	2.45	37.63
1911	3.39	2.64	3.73	4.00	1.11	1.62	5 22	4.73	2.81	2.69	7.85	4.10	43.89
1912	4.36	3.77	7.55	4.67	4.84	0.35	1.28	3.67	1.40	1.14	4.21	7.75	44.99
1913	4.43	3.75	4.90	5.93	1.74	1.56	2.67	3.65	3.12	9.99	2.96	4.35	49.05
Av.	4.82	4.51	4.56	3.99	3.52	2.88	3.57	3.74	3.51	4.07	4.33	4.11	47.61

RAINFALL AT TEMPLETON, MASS. Elevation, 1 000 feet.
(Baldwinville.)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1907	2.10	2.10	2.20	2.80	4.10	2.80	6.10	1.50	9.20	5.00	4.80	3.40	46.10
1908	2.30	3.30	2.10	2.00	3.90	1.80	2.60	7.90	1.20	1.30	0.90	2.30	31.60
1909	3.90	4.80	2.80	4.60	1.70	1.10	1.60	2.50	3.60	0.70	1.70	3.30	32.30
1910	5.20	3.70	0.80	3.00	1.80	2.10	2.20	3.30	2.20	1.10	3.50	1.90	30.80
1911	2.40	1.90	4.30	2.00	1.40	1.20	3.20	5.80	1.70	5.08	3.00	3.00	34.98
1912	2.43	1.90	5.52	4.47	4.92	0.99	2.30	2.31	2.96	3.40	4.24	4.18	39.62
Av.	3.06	2.95	2.95	3.15	2.97	1.67	3.00	3.88	3.48	2.76	3.02	3.01	35.90

RAINFALL AT THATCHER'S ISLAND, MASS. Elevation, 25 feet.

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1876	1.93	5.27	6.91	4.71	2.47	1.61	6.60	0.37	4.12	1.75	9.46	2.32	47.52
1877	2.26	0.95	8.61	4.42	1.73	2.45	3.65	1.86	0.51	7.15	7.57	1.37	42.53
1878	6.21	4.99	5.12	5.29	0.93	1.52	4.28	6.62	1.02	7.57	9.30	5.53	58.38
1879	3.68	2.42	5.80	6.12	1.08	4.25	2.17	7.56	0.99	0.90	6.91	4.05	45.93
1880	2.31	2.37	4.07	8.53	2.37	2.14	6.51	4.15	3.72	2.81	4.32	2.81	46.11
1881	4.56	4.73	9.96	1.56	7.22	7.51	2.89	0.85	3.76	3.19	11.18	6.80	64.21
1882	5.00	4.69	3.60	2.73	8.72	1.33	2.90	1.12	7.40	2.40	2.46	3.34	45.69
1883	5.12	3.41	2.00	1.87	2.62	2.02	5.46	2.67	0.78	5.47	3.40	5.29	40.11
1884	7.66	7.54	4.70	3.21	4.39	2.79	2.93	5.30	0.77	2.86	2.67	5.82	50.64
Av.	4.30	4.04	5.64	4.27	3.50	2.85	4.16	3.39	2.56	3.79	6.36	4.15	49.01

RAINFALL AT VINEYARD HAVEN, MASS. Elevation, 40 feet.

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1894	5.51	4.06	2.26	4.70	4.78	1.47	1.47	1.74	3.00	10.88	5.73	6.87	52.47
1895	4.19	0.95	4.58	3.14	4.23	2.51	6.37	3.47	1.15	2.45	5.77	4.71	43.52
1896	2.04	5.01	5.70	1.37	4.13	3.59	3.59	2.81	6.63	5.82	2.93	3.08	46.70
1897	3.89	2.68	3.61	5.95	3.28	2.83	5.28	5.04	0.80	2.44	6.42	4.52	46.74
1898	4.83	4.51	4.27	6.69	6.19	0.81	4.74	4.77	1.02	7.24	11.01	2.96	59.04
1899	3.72	6.39	8.87	3.05	1.73	4.51	3.86	2.76	3.15	3.11	1.97	1.57	44.69
1900	5.77	6.37	4.05	4.64	3.17	...	...	...	...	...	...	...	....
Av.	4.03	3.93	4.88	4.15	4.06	2.62	4.22	3.43	2.63	5.32	5.64	3.95	48.86

RAINFALL AT WAKEFIELD, MASS. Elevation, 100 feet.

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1890	2.50	3.61	7.49	2.33	6.51	3.13	1.80	4.21	4.06	8.58	1.53	5.62	51.37
1891	6.23	4.60	6.46	3.04	2.35	4.09	2.95	2.51	1.66	4.66	2.52	3.55	44.62
1892	3.82	3.26	4.82	0.65	5.83	3.84	1.54	5.45	1.87	2.28	5.51	1.31	40.18
1893	2.48	8.39	2.41	3.42	6.77	1.82	1.67	5.94	1.79	4.32	2.15	4.72	45.88
1894	3.33	3.42	1.10	3.11	4.91	0.22	2.73	1.07	2.40	5.40	4.37	3.27	35.33
1895	4.18	1.12	3.07	4.03	3.17	4.40	4.81	3.67	1.76	7.00	9.71	2.37	49.29
1896	2.80	5.25	5.42	1.69	2.54	2.16	2.83	2.38	8.20	3.34	3.59	1.84	42.04
1897	4.50	2.67	3.63	2.88	5.66	6.50	3.60	3.35	2.57	0.36	6.74	4.30	46.76
Av.	3.73	4.04	4.30	2.64	4.72	3.27	2.74	3.57	3.04	4.49	4.52	3.37	44.43

RAINFALL AT WALTHAM, MASS. Elevation, 20 feet.
(Waltham Water Works Pumping Station.)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1880	3.10	3.88	3.03	2.14	1.69	1.06	8.32	4.38	1.64	3.06	2.20	1.39	35.89
1881	2.81	4.48	5.40	1.76	3.47	6.26	4.27	0.96	2.49	3.04	3.53	3.45	41.92
1882	3.64	3.12	2.48	2.51	5.20	1.90	2.52	1.32	9.59	2.28	0.73	2.17	37.46
1883	3.16	3.92	2.26	2.88	4.78	2.86	3.76	0.38	1.05	6.08	2.32	2.55	36.00
1884	4.29	6.26	4.19	3.61	2.91	3.54	5.27	4.55	0.63	1.21	1.95	4.76	43.17
1885	4.99	3.15	0.48	3.52	3.41	4.24	2.53	6.12	1.88	4.82	6.02	3.62	44.78
1886	5.12	7.83	3.06	1.76	3.28	1.33	2.72	2.52	3.14	3.10	4.74	3.69	42.29
1887	5.48	5.14	5.01	3.31	1.27	2.62	4.33	4.75	0.78	2.98	2.27	4.30	42.24
1888	4.26	3.58	5.63	3.18	4.48	1.96	1.70	6.87	9.28	5.09	7.53	5.99	59.55
1889	6.73	1.50	1.87	4.43	5.23	3.33	10.63	3.38	4.34	3.96	6.20	2.66	54.26

RAINFALL AT WALTHAM, MASS. — *Continued.*

(Waltham Water Works Pumping Station.)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1890	2.18	2.97	5.89	2.48	5.76	2.59	2.13	3.05	5.50	10.28	1.35	5.05	49.23
1891	6.11	5.37	4.97	3.05	1.68	3.83	2.97	4.66	2.69	3.61	2.60	2.83	44.37
1892	3.76	2.07	2.97	0.91	6.11	4.30	3.27	4.00	2.48	3.15	3.96	1.25	38.23
1893	2.13	4.55	2.60	4.18	4.15	2.53	2.83	6.79	1.75	4.05	2.01	4.38	41.95
1894	1.67	1.53	1.08	2.24	4.61	0.10	3.00	1.37	2.04	4.72	2.66	3.46	28.48
1895	3.38	0.85	2.38	4.23	2.07	4.13	4.49	5.01	2.41	10.73	5.60	1.97	47.28
1896	2.03	6.03	3.36	1.50	1.88	2.55	2.72	2.37	8.75	3.41	3.25	2.43	40.28
1897	3.84	2.10	3.09	2.72	1.71	5.03	5.23	4.77	2.85	0.15	6.27	3.65	44.41
1898	1.46	5.30	1.11	6.36	3.14	1.73	5.68	7.17	1.80	7.42	5.72	3.21	53.40
1899	4.34	3.11	6.28	1.55	0.85	3.38	2.39	2.97	1.91	2.73	2.54	1.60	36.65
1900	4.54	8.54	5.21	2.36	5.52	2.99	2.70	2.30	3.60	3.98	5.22	2.81	49.77
1901	1.36	0.84	6.89	8.11	7.95	1.31	5.50	4.85	4.17	2.74	3.16	8.10	54.98
1902	1.89	6.32	3.75	4.52	1.18	2.53	4.02	3.80	4.81	4.85	1.12	4.48	43.27
1903	3.89	3.90	6.92	3.84	1.00	8.53	3.93	3.90	1.92	4.55	1.69	2.49	46.56
1904	4.30	2.62	2.58	9.61	3.25	3.14	1.69	3.54	6.91	1.88	1.96	2.78	44.29
1905	5.11	1.12	3.46	3.13	1.88	5.33	2.56	3.02	7.64	1.24	2.42	3.76	40.67
1906	2.59	2.76	6.02	2.54	5.12	2.83	5.11	2.58	2.95	3.04	2.99	4.93	43.46
1907	2.88	1.89	1.51	3.33	3.40	2.67	1.48	1.66	8.92	3.49	6.89	3.03	41.15
1908	3.83	4.05	3.52	1.97	3.99	1.14	3.53	4.23	0.90	3.07	0.87	2.91	34.01
1909	4.21	5.59	3.91	4.57	1.82	2.96	1.59	3.17	4.94	1.14	3.47	4.37	41.74
1910	5.11	4.95	0.82	2.38	1.52	4.59	2.33	1.14	2.99	1.60	4.33	2.21	33.97
1911	2.91	2.99	3.16	2.12	0.67	3.92	4.83	5.03	3.90	2.97	4.77	4.35	41.92
1912	3.16	2.85	6.27	4.26	5.04	0.31	4.38	2.82	1.93	2.56	3.20	5.60	42.38
1913	3.16	2.94	5.74	4.42	4.35	1.08	3.29	3.95	3.99	6.19	2.43	2.01	43.55
Av.	3.72	3.77	3.73	3.41	3.46	3.02	3.75	3.63	3.81	3.80	3.47	3.48	43.05

RAINFALL AT WALTHAM, MASS. Elevation, 30 feet.

(Boston Manufacturing Company.)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1825	2.16	**3.43**	6.03	0.48	1.91	5.07	1.14	5.95	2.63	2.86	0.71	5.65	38.02
1826	2.88	1.00	4.23	1.94	0.49	4.04	2.08	7.23	4.15	4.14	2.68	2.58	37.44
1827	**3.92**	**2.97**	6.74	4.26	5.44	2.14	2.71	5.59	7.48	5.95	6.58	3.76	57.54
1828	2.05	3.40	2.88	2.58	6.25	6.16	5.00	0.64	3.47	3.17	5.82	0.30	41.72
1829	4.80	1.98	4.12	4.07	3.13	2.88	5.99	3.21	2.90	1.69	5.74	1.58	42.09
1830	3.14	**1.63**	2.17	3.01	3.81	4.01	6.09	4.54	4.82	2.21	7.57	5.63	48.63
1831	0.64	1.48	4.99	8.63	3.84	4.42	5.13	3.41	4.56	4.95	3.47	0.25	45.77
1832	5.18	2.78	3.60	5.42	7.41	0.54	3.23	5.83	1.78	3.13	4.47	3.84	47.21
1833	1.58	2.02	2.16	3.59	2.91	3.97	3.38	1.33	3.86	6.82	6.22	**5.86**	43.70
1834	**1.39**	0.64	1.31	3.53	6.49	3.69	4.88	2.65	2.93	5.59	2.42	1.37	36.89
1835	3.82	0.88	3.28	4.74	2.18	2.16	8.63	3.47	2.39	3.76	1.67	2.32	39.30
1836	2.72	3.50	2.26	3.00	2.17	3.73	2.40	0.97	1.06	3.55	5.02	4.72	35.10
1837	3.62	3.99	2.34	4.08	6.88	4.06	1.66	2.32	0.66	2.14	2.69	3.54	37.98
1838	2.88	1.89	1.36	3.46	3.43	5.09	1.86	4.74	6.66	1.82	3.56	1.00	40.75
1839	0.98	2.38	1.06	5.76	5.58	3.16	3.71	4.83	1.40	2.39	1.95	5.60	38.80
1840	1.68	2.78	3.28	5.17	2.28	2.41	2.09	5.22	2.89	3.65	7.35	3.20	42.00
1841	4.98	1.12	2.38	6.60	2.02	1.17	2.42	4.84	4.62	3.37	3.67	4.51	41.70
1842	1.04	3.38	2.51	3.16	2.54	5.90	2.20	4.70	2.86	0.96	3.67	5.32	38.24
1843	2.76	1.64	5.78	4.30	0.82	3.73	2.77	8.60	1.02	5.54	3.50	**3.34**	43.80
1844	4.14	**2.03**	4.20	0.24	3.30	1.26	2.44	2.85	4.20	5.86	3.14	2.46	36.12

RAINFALL AT WALTHAM, MASS.— *Continued.*

(Boston Manufacturing Company.)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1845	3.44	1.70	2.84	1.76	2.62	2.63	3.84	3.30	2.55	3.80	10.28	4.28	43.04
1846	2.58	1.50	4.38	1.57	3.66	2.44	2.38	2.18	0.82	1.09	2.04	3.76	28.40
1847	3.08	3.84	3.26	3.10	2.36	5.94	2.36	4.18	6.88	1.72	4.16	3.02	43 90
1848	3.24	1.56	4.08	1.56	5.96	3.10	1.92	2.28	3.32	4.60	1.68	2 93	36.23
1849	1.36	0.40	6.66	1.32	3.62	2.00	2.16	5.36	1.94	8.00	4.60	3.32	40.74
1850	4.96	2.96	4.12	5.45	7.56	3.72	3.48	9.64	9.92	2.64	3.36	4.32	62.13
1851	1.36	3.92	1.20	8.98	3.60	1.64	3.23	0.99	3.64	4.85	5.34	2.25	41.00
1852	1.83	2.27	4.04	7.70	1.68	3.26	2.11	7.69	2.08	2.10	4.15	3.33	42.24
1853	2.18	5.36	2.33	3.34	6.29	0.95	2.72	7.78	4.50	2.30	5.43	1.86	45.04
1854	1.82	4.25	2.80	4.88	4.03	1.87	2.16	0.57	4.36	3.68	6.62	4.25	41.29
1855	6.44	3.56	0.86	4.34	0.93	3.58	5.40	2.08	0.79	4.48	4.12	4.05	40.63
1856	1.13	0.17	0.63	3.33	5.17	1.59	4.27	13.97	4.79	2.23	3.09	1.96	42.33
1857	2.68	1.40	2.03	7.78	4.56	1.88	6.99	4.77	2.20	4.60	2.04	3.11	44.04
1858	2.00	1.53	0.86	4.10	3.22	6 42	4.02	4 02	3.86	2.21	2.08	3.08	37.40
1859	5.89	2.83	7.36	2.32	3.84	5.03	1.59	5.64	3.96	2.80	3.05	4.18	48.49
1860	1.46	1.58	1.76	1.06	2.21	6.01	5.08	7.52	7.96	2.01	4.82	4.50	45.97
1861	2.56	3.24	3.07	4.60	2.54	2.20	2.83	5.13	2.14	1.91	4.31	1.98	36.51
1862	5.11	2.15	3.66	1.00	2.45	6.10	7.09	3.65	2.89	4.35	5.72	2.25	46.42
1863	2.34	4.06	2.64	7.82	2.23	2.40	11.66	4.39	2.16	3.04	5.92	5.00	53.66
1864	3.00	0.90	6.84	4.44	2.20	0.70	1.16	2.51	2.30	4.97	4.04	3.50	36.56
1865	1.40	2.63	4.25	2.25	6.28	1.36	3.52	2.45	0.82	5 01	3.91	1.96	35.84
1866	1.20	4.78	3.50	1.36	5.50	3.49	5.70	3.42	6.86	1 94	2.60	3.11	43.46
1867	2.50	2.22	4.88	2.49	3.84	2.15	5.30	8.78	0.74	5.16	1.98	1.36	41.40
1868	3 14	0.70	2.43	5.91	10.00	2.00	2.07	4.45	7.12	2.04	3.67	1.12	44.65
1869	6.44	1.00	5.26	2.03	5.03	3.60	2.90	2.06	6.45	5.95	2.08	4.50	47.30
1870	4.60	4.94	3.72	6.58	1.37	4.46	1.90	0.92	1.40	4.83	2.98	1.70	39.40
1 71	1.76	2.64	3.86	3.39	3.28	4.02	2.17	2.52	1.08	5.28	4.70	2.12	36.82
1872	0.68	2.18	3.04	1.80	3.32	4.20	5.24	10.96	6.32	3.60	3.52	0.94	45.80
1873	4.20	2.22	2.72	2.72	3.22	0.80	3.48	6.49	2.91	5.76	4.84	3.22	42.58
1874	2.72	1.63	1.13	6.08	3.16	2.88	2.62	5.96	1.50	0.96	1.90	1.78	32.32
1875	2.04	2.08	3.52	3.54	2.76	5.84	3.56	4.88	2.90	4.00	4.22	0.96	40.30
1876	1.60	4.08	7.16	4 00	2.89	1.58	9.38	1.75	4.00	2.54	6.48	1.88	47.34
1877	2.06	0.72	6.96	3.59	3.59	1.68	2.82	4.92	0.79	7.61	6.99	0.89	42.62
1878	5.35	4.03	4.07	5.11	0.62	2.20	6.15	10.91	1 67	5.03	6.03	4 08	55.25
1879	0.99	1.88	3.06	4.59	1.00	3.61	3.17	5.56	1.71	0.70	2.67	2.92	31.86
1880	3.31	2.56	3.16	2.20	1.48	0.96	6.84	3.80	1.40	3.00	1.24	1.78	31.73
1881	4.04	3.56	4.80	1.68	2.68	5.74	3.18	0.72	1.84	1.52	4.82	3.16	37.74
1882	3.60	3 04	2.92	1.84	4.52	1.86	1.76	0.36	8.64	2.20	1.04	1.24	33.02
1883	2.58	3.00	1.48	2.48	4.20	1.84	2.84	0 00	1.08	5.04	2.18	2.60	29 32
1884	4.44	6.16	4.24	3.52	2.44	3.16	4.84	4.12	0 60	2.96	1.92	4.40	42.80
1885	4.32	2.84	0.48	3.42	3.43	4.69	2 32	5.80	1.74	5.01	6.24	2.22	42.51
1886	7.12	7.84	3.57	2.51	3.18	1.29	3.03	2.78	2 96	2.78	4.28	6.25	47.59
1887	5.99	4.66	5.23	4.76	1.62	2.97	4.58	4.64	1.59	2.91	2.87	4.13	45.95
1888	4.22	3.04	5.17	2.72	5.20	2.14	1.68	6.22	8.50	4.65	9.16	5.72	58 12
1889	6.24	1.53	2.03	4.35	5.35	3.29	9.90	3.50	4.26	3.62	6.08	2.96	53 11
1890	2.30	3.28	7.04	2.51	5.66	2.56	2.13	3.66	4.91	10.48	1.34	5.15	51.02
1891	5.71	4.83	5.96	3.14	1.93	4.02	2 83	5.32	2.53	4.34	2.67	3 90	47.18
1892	5.12	2.71	3.59	0.88	5.81	3.98	2.69	4.12	2.32	1.58	5.94	0.93	39.67
1893	2.31	7.65	2.99	2.94	5.06	2.06	2.46	8 40	1.62	4.13	2.21	5.22	47 05
1894	2.54	2.65	1 20	3.29	4 57	0.51	3 16	1.48	2.29	5 92	3.83	4 30	35.74

RAINFALL AT WALTHAM, MASS. — *Concluded.*

(Boston Manufacturing Company.)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1895	4.08	1.29	3.01	4.67	2.03	3.67	4.04	4.92	2.55	11.08	6.17	2.61	50.12
1896	2.77	4.56	6.29	2.15	2.01	2.65	2.54	2.35	7.22	3.23	3.41	1.24	40.42
1897	4.16	2.64	3.44	2.79	4.64	5.18	3.70	3.54	2.45	0.23	6.76	4.33	43.86
1898	6.19	3.42	2.18	6.54	3 39	1.92	5.74	6.37	1.62	6.93	6.50	3.30	54.10
1899	4.57	4.20	7.28	1.58	1.05	3.48	2.76	2.69	4.72	2.77	2.35	2.09	39.54
1900	4.92	8.00	5.23	2.28	4.78	2.70	2.52	2.20	4 97	4.13	5.26	2.78	49.77
1901	1 36	1.20	6.76	8.62	8.31	1.15	5.34	4.47	3.93	2.72	3.52	8.83	56.21
1902	1.92	4.59	3.71	4.17	1.24	2.72	3.59	3.83	4.93	4.88	1.09	5.04	41.71
1903	4.76	4.23	6 85	4.21	1.75	8.29	3.83	3.54	2.17	4.74	1.82	4.20	50.39
1904	5.85	3.32	3.10	10.56	3.04	2.98	2.64	3.35	7.22	1.41	2.13	2.82	48.42
1905	5.11	1.09	3.25	3.15	1.73	4.52	1.20	3.30	5.40	1.52	2.34	4.79	37.40
1906	3.10	2.76	5.43	3.24	5.49	4.41	3.53	2.78	3.08	3.15	3.11	5.09	45.17
1907	2.87	2.49	2.03	3.99	3.45	2.76	1.56	1.19	8.97	3.62	7.14	4.06	44.13
1908	9.14	4.05	4.03	1.87	3.59	2.00	3.80	4.06	0.83	3.29	0.83	2.60	40.09
1909	3.22	5.56	4.14	4.11	2.29	3.26	2.05	3.43	5.47	1.08	4.04	4.74	43.39
1910	5.11	4.95	0.85	2.65	1 07	4.82	1.58	0.65	2.86	1.69	4.93	2.65	33.81
1911	2.48	2.85	3.62	2.70	0.85	4.66	4.65	6.73	3.84	3.50	5.24	4.28	45.40
1912	3.16	2.52	5.89	4.98	4.70	0.30	4.65	2.58	1.79	2.05	3.05	4.70	40.37
1913	2.99	2.73	5.90	4.12	4.11	1.10	3.06	4.16	3.63	6.11	1.10	1.95	40.96
Av.	3.34	2.90	3.69	3.76	3.55	3.15	3.63	4.24	3.48	3.74	3.98	3.28	42.74

RAINFALL AT WALTHAM, MASS. Elevation, 180 feet.

(Hobbs Brook Reservoir, Cambridge Water Works.)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1895	3.39	0.87	2.66	4.40	1.82	4.61	4.68	3.03	2.19	9.87	6.17	1.84	45.53
1896	2.33	5.74	3.58	1.48	2.09	2.21	2.12	3.05	6.81	2.74	2.83	1.97	36.95
1897	4.26	2.86	3.22	2.44	4.19	4.17	4.13	3.89	3.13	0.21	4.54	4.40	41.44
1898	5.91	2.82	3.08	5.72	3.03	2.22	5.33	7.22	2.37	6.17	6.14	1.83	51.84
1899	2.40	4.49	5.22	1.30	1.34	3.15	3.23	3.17	4.08	1.83	3.50	1.58	35.29
1900	4 47	8.08	5.14	2.38	4.84	2.10	2.41	2.14	4.67	3.40	4.68	2.29	46.60
1901	1.34	1.10	5.52	6.72	7.67	1.22	5.83	3.59	2.95	2.75	2.77	8.15	49.61
1902	1.62	3.00	5.10	3.85	1.62	2.22	3.12	4.09	4.04	4.46	0.97	5.84	39.93
1903	3.24	3.34	6.09	3.31	0.82	8.47	3.89	4.08	2.45	4.57	1.48	2.45	44.19
1904	3.01	2.10	2.50	8.55	4.05	3.18	2.35	3.60	5.87	1.73	1.51	2.06	40.51
1905	4.54	1.65	3.27	2.67	1.32	5.90	2.10	3.40	7.45	1.43	2.17	3.70	39.60
1906	2.38	2.88	5.10	2.45	4.70	2.59	5.03	2.75	2.47	2.70	2.47	4.15	39.67
1907	2.53	1.61	1.92	3.37	3.08	2.80	1.90	1.47	7.67	3.30	5.40	2.94	37.99
1908	2.95	3.32	2.67	1.40	4.10	1.55	4.17	4.55	0.90	2.75	0.80	2.50	31.66
1909	3.85	5.05	3.15	3.90	2.20	3.15	3.40	2.85	4.20	1.15	2.95	2.35	38.20
1910	4.33	3.34	1.25	2.45	1.00	3.40	1.50	2.10	2.65	1.31	3.85	2.17	29.35
1911	2.84	2.89	3.20	1.82	0.67	3.23	4.51	4.60	3.40	3.00	4.53	3.43	38.12
1912	2.60	2.25	5.86	3.87	5.22	0.22	5.85	1.97	2.00	2.95	2.85	1.50	40.14
1913	2.87	2.85	5.07	4.33	3.87	1.47	3.25	3.85	2.95	5.82	2.00	2.72	41.05
Av.	3.20	3.17	3.87	3.50	3.03	3.05	3.62	3.44	3.80	3.27	3.24	3.21	40.40

RAINFALL AT WEBSTER, MASS. Elevation, 450 feet.

(Slater and Sons Mill.)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1880	2.84	2.50	3.52	3.42	1.79	3.30	7.94	4.03	1.59	2.95	1.98	1.77	37.63
1881	3.94	4.19	5.28	1.29	4.15	4.04	3.39	1.69	1.43	2.27	4.64	3.90	40.21
1882	5.07	4.50	3.03	2.09	4.10	1.81	0.95	1.60	9.09	2.18	1.53	2.46	38.71
1883	3.00	4.87	2.17	1.24	4.08	3.23	2.14	1.69	2.10	5.20	1.60	3.24	34.56
1884	5.25	6.52	4.92	4.43	4.02	3.85	3.78	3.48	0.92	2.42	2.87	5.82	48.28
1885	4.15	4.42	1.14	2.15	3.40	1.84	1.61	5.67	1.64	3.97	4.50	3.07	37.56
1886	5.47	6.45	3.22	2.09	3.19	1.66	5.00	5.23	3.05	2.31	4.54	5.02	47.23
1887	5.18	5.58	5.22	5.13	1.89	2.78	7.90	5.48	1.09	2.62	2.71	4.35	49.93
1888	3.13	3.74	8.30	2.77	4.61	2.43	1.79	4.83	8.36	6.03	5.45	5.28	56.72
1889	4.76	1.89	1.97	3.40	3.23	2.83	10.53	3.61	3.44	4.91	5.29	2.21	48.07
1890	2.20	3.11	7.19	2.89	5.50	3.14	3.10	4.08	4.55	7.80	1.05	4.99	49.60
1891	8.86	5.44	4.94	3.22	1.77	2.95	3.85	4.43	2.13	2.85	2.72	3.67	46.83
1892	5.36	1.92	3.45	0.56	5.86	3.09	3.55	5.48	1.81	1.20	5.98	1.33	39.59
1893	2.52	6.96	3.69	3.43	5.02	2.05	0.70	3.66	2.70	4.23	2.10	4.28	41.34
1894	3.01	3.85	1.40	3.83	3.97	0.59	1.67	2.01	1.96	3.32	4.16	4.28	34.05
1895	4.19	1.17	3.11	4.09	2.42	3.01	5.07	3.17	3.37	8.28	5.95	2.97	46.80
1896	2.01	6.38	5.07	1.43	1.92	3.19	3.33	2.60	7.20	2.88	2.61	1.86	40.48
1897	3.29	2.49	3.44	2.20	3.95	2.63	6.63	4.10	2.26	1.00	6.17	5.03	43.19
1898	4.05	4.42	2.66	3.69	3.08	2.77	7.20	4.85	2.79	5.82	7.10	2.23	50.66
1899	4.15	4.44	6.84	1.98	1.50	3.55	3.69	1.87	3.72	1.24	2.05	1.66	36.69
1900	4.18	6.95	5.61	2.07	4.69	4.52	3.85	1.39	1.61	3.62	5.08	2.15	45.72
1901	1.08	1.05	5.02	6.36	6.00	1.13	3.90	4.84	3.96	3.32	2.57	9.43	48.66
1902	2.20	5.20	5.23	3.14	1.30	3.54	4.12	3.22	5.11	5.40	1.15	6.03	45.64
1903	3.66	4.46	7.01	2.85	0.90	7.93	3.18	4.67	1.98	3.57	1.88	3.37	45.46
1904	3.34	2.37	3.64	6.81	2.47	2.62	2.13	5.09	4.74	1.83	1.67	2.79	39.50
1905	3.83	1.72	3.15	2.95	1.08	3.88	1.00	4.47	6.60	1.86	2.63	4.14	37.31
1906	2.82	2.92	5.40	2.95	6.49	3.20	4.88	1.97	2.67	4.49	1.85	4.11	43.75
1907	2.91	1.85	2.08	3.16	3.44	3.74	2.19	0.75	8.65	4.72	6.02	4.89	44.40
1908	2.00	2.96	4.54	3.34	4.03	2.80	3.60	8.33	1.16	2.25	0.97	3.30	39.28
1909	3.13	5.90	3.32	5.03	2.46	2.11	1.95	1.91	5.06	1.01	2.34	3.82	38.04
1910	5.44	3.80	1.48	3.10	1.79	4.14	1.46	1.84	1.86	1.58	3.80	2.07	32.36
1911	2.87	2.65	3.55	2.96	0.42	1.51	3.28	6.00	4.51	3.93	4.60	3.44	39.72
1912	1.62	2.98	7.51	4.92	4.42	0.50	4.05	3.38	1.41	1.85	3.44	5.21	41.29
1913	2.82	3.00	6.27	4.74	2.84	2.36	1.67	4.73	4.14	6.35	1.82	4.15	44.89
Av.	3.66	3.90	4.25	3.23	3.30	2.90	3.68	3.71	3.49	3.51	3.37	3.77	42.77

RAINFALL AT WENHAM LAKE (BEVERLY), MASS. Elevation, 60 feet.

(Salem Water Works Pumping Station.)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1874	3.26	1.04	2.00	8.21	3.01	2.19	4.28	7.10	1.78	0.50	1.52	2.41	37.30
1875	2.80	1.57	4.38	2.78	4.06	7.39	3.92	6.00	3.46	6.72	6.13	0.94	50.15
1876	1.66	4.29	7.96	3.28	3.65	0.79	7.56	0.75	6.72	1.78	10.68	2.70	51.82
1877	2.50	0.72	7.22	5.12	2.60	2.70	2.64	4.32	0.16	8.15	8.16	1.14	45.43
1878	7.74	6.49	4.20	5.97	0.94	2.16	4.69	11.98	1.94	5.92	7.23	5.36	64.62
1879	1.25	2.50	4.09	4.50	1.98	5.22	2.52	6.47	2.00	1.00	2.80	3.50	37.83
1880	3.10	3.72	3.09	2.00	2.06	1.72	8.11	2.94	1.80	2.38	2.32	3.06	36.30
1881	5.32	3.94	5.44	1.92	4.56	5.52	3.72	1.24	2.54	3.04	4.30	3.40	44.94
1882	4.16	3.16	3.29	2.32	5.34	2.96	3.80	0.80	8.00	1.76	1.52	2.56	39.67
1883	3.32	3.30	3.10	2.48	4.26	3.84	4.64	2.72	1.64	6.02	2.56	2.14	40.02

RAINFALL AT WENHAM LAKE, MASS.—*Continued.*

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1884	5.28	9.12	6.44	5.52	4.18	3.40	2.70	4.50	0.92	3.46	3.32	5.44	54.28
1885	5.57	3.12	0.83	4.44	4.40	4.63	1.37	6.67	1.60	7.76	7.30	2.06	49.75
1886	6.04	9.55	4.46	2.24	2.57	1.76	4.32	1.44	3.16	4.50	5.79	4.40	50.23
1887	5.87	4.63	5.68	3.91	2.06	2.10	3.03	4.77	1.56	1.58	3.02	3.47	41.68
1888	3.60	2.70	3.92	3.14	5.26	1.34	1.84	4.52	7.26	4.47	5.71	5.36	49.12
1889	4.90	1.26	2.36	3.13	3.86	3.93	7.90	4.26	4.56	4.26	7.56	2.85	50.83
1890	3.06	3.78	5.03	2.35	6.40	4.02	2.69	3.88	3.90	6.64	1.46	4.35	47.56
1891	5.73	4.27	3.45	2.04	1.60	5.09	4.28	3.42	1.90	4.94	2.42	4.09	43.23
1892	3.69	1.92	3.19	0.71	4.52	3.83	2.04	4.50	1.91	2.18	4.25	1.11	33.85
1893	1.20	4.92	0.96	3.29	6.76	2.93	1.45	6.25	1.56	3.76	1.97	4.69	39.74
1894	2.17	2.09	1.21	1.94	5.39	0.25	2.88	2.03	2.64	7.53	3.16	3.33	34.62
1895	2.91	0.44	3.16	3.60	2.38	3.91	4.11	3.44	1.78	6.53	10.71	2.26	45.26
1896	2.27	5.41	3.92	0.83	2.07	2.17	2.98	2.40	7.01	4.14	3.91	1.40	38.81
1897	2.51	1.43	3.21	3.14	6.17	4.76	5.39	3.38	3.19	0.36	6.61	4.21	44.36
1898	5.18	3.59	1.43	6.07	5.00	2.17	5.45	8.46	2.26	9.16	4.38	1.26	54.41
1899	4.18	1.99	6.16	1.91	1.43	4.42	2.68	2.58	5.47	2.43	2.09	1.88	37.22
1900	4.24	7.36	4.28	2.09	4.56	3.47	2.35	2.93	4.19	3.18	3.85	2.00	44.50
1901	1.40	0.22	7.02	8.65	7.09	2.51	4.43	3.20	4.23	2.59	2.56	7.18	51.08
1902	1.80	5.26	4.33	4.72	2.84	2.48	3.09	4.07	3.92	5.58	1.06	4.68	43.83
1903	3.91	3.48	6.45	5.16	0.26	11.70	3.03	4.06	2.90	3.13	1.23	2.38	47.72
1904	3.08	2.58	2.50	10.52	4.66	5.49	1.78	3.31	5.71	2.48	1.51	1.75	45.37
1905	2.59	1.49	2.51	2.74	1.19	5.53	1.27	2.66	8.24	1.37	2.68	4.43	36.70
1906	2.99	2.32	4.74	2.66	5.42	3.35	6.67	2.75	2.19	3.63	3.04	5.79	45.55
1907	2.59	1.18	2.06	2.70	3.70	4.71	4.36	0.99	8.83	3.04	6.01	4.39	44.56
1908	2.40	2.90	3.09	2.01	4.29	0.69	4.42	4.73	0.86	4.85	1.24	3.25	34.73
1909	3.71	4.76	2.73	4.17	2.02	2.79	2.64	2.99	6.14	2.15	4.16	3.11	41.37
1910	4.13	3.09	1.54	2.04	1.36	5.26	2.05	1.48	2.32	1.33	3.75	2.85	31.20
1911	2.78	2.75	3.74	1.86	0.46	4.18	6.50	3.64	3.75	2.69	4.99	3.92	41.26
1912	2.60	2.68	4.92	3.74	4.49	0.55	5.52	2.30	2.85	1.91	3.25	4.70	39.51
1913	2.73	3.52	3.96	4.62	3.17	1.17	2.31	2.88	3.02	6.04	1.93	3.57	38.92
Av.	3.51	3.36	3.85	3.61	3.55	3.48	3.79	3.82	3.50	3.88	4.05	3.33	43.73

Beginning with January, 1912, a standard gage was placed beside the old gage at this station, and the results of a comparison of the standard gage with the observations of the old gage for twenty-nine months indicate that the old gage recorded too great an amount of rainfall by about 10.7 per cent. It is advisable that the readings given in the above table be reduced by that amount beginning with 1899. It is possible that the records of the old gage are also too high for earlier years. The difference is caused by a flange around the upper edge of the gage.

RAINFALL AT WESTBOROUGH, MASS. Elevation, 298 feet.

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1875	1.95	4.05	4.55	2.85	3.00	5.12	3.88	4.13	2.49	4.75	3.50	0.50	40.77
1876	1.40	3.75	6.85	4.42	2.95	2.47	8.50	1.92	4.68	2.20	5.13	3.10	47.37
1877	3.37	0.89	8.79	3.16	3.45	1.67	3.33	3.99	0.25	8.37	5.79	0.77	43.83
1878	5.40	6.12	4.49	5.28	0.99	3.53	2.95	6.14	1.15	6.19	6.97	6.12	55.33
1879	2.53	3.31	5.21	4.99	1.27	4.18	3.81	6.57	1.88	0.76	2.54	4.04	41.09
1880	4.06	3.52	3.17	2.78	1.58	2.06	6.80	3.44	1.72	3.68	1.57	2.85	37.23
1881	5.45	5.12	5.69	2.07	3.67	4.75	2.07	1.45	2.47	3.12	3.85	4.10	43.81
1882	4.43	7.32	2.36	1.84	5.10	1.46	1.62	1.37	8.12	1.77	1.12	2.35	38.86
1883	2.77	4.12	1.87	1.71	4.54	2.78	2.60	0.93	1.38	5.54	1.72	3.65	33.61
1884	5.25	7.12	5.11	4.29	3.66	3.75	3.58	3.16	1.13	2.38	2.95	5.49	47.87

RAINFALL AT WESTBOROUGH, MASS. — *Continued.*

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1885	4.47	4.34	1.05	3.52	2.98	3.23	1.56	7.19	1.34	4.48	6.14	3.07	43.37
1886	5.74	6.28	3.63	2.40	3.01	1.63	3.38	2.16	2.76	2.98	4.82	4.06	42.85
1887	4.85	4.49	4.35	3.36	1.27	2.88	3.71	5.94	1.35	2.80	2.70	3.85	41.55
1888	3.32	3.66	5.77	2.27	5.15	2.27	0.97	5.93	8.18	4.69	6.31	4.98	53.50
1889	5.38	1.63	2.03	3.47	1.84	2.18	8.54	3.86	4.34	4.12	6.30	2.76	46.45
1890	2.42	3.62	6.82	2.62	4.41	1.76	2.43	3.53	3.92	10.85	1.07	4.17	47.62
1891	6.05	4.21	5.89	2.63	1.85	3.14	2.87	3.02	2.62	2.95	2.80	3.25	41.28
1892	5.04	2.46	3.46	0.70	5.59	2.31	2.64	6.40	1.96	0.90	6.15	1.16	38.77
1893	2.40	6.98	3.70	3.59	6.62	2.11	2.15	4.27	1.86	4.03	2.02	4.59	44.32
1894	3.10	3.64	1.40	3.48	4.46	1.02	3.59	6.09	2.20	4.98	3.46	3.78	41.20
1895	3.59	1.35	2.39	4.08	2.09	3.16	4.20	4.98	2.13	9.79	6.79	2.60	47.15
1896	2.15	4.20	6.13	1.29	2.50	3.34	2.41	3.15	7.74	4.14	2.77	1.63	41.45
1897	2.44	2.70	3.91	2.43	4.04	4.53	6.49	2.66	2.22	0.62	6.55	5.29	43.88
1898	4.20	5.19	2.32	4.34	3.04	3.15	4.00	9.02	2.61	6.27	5.95	2.24	52.33
1899	4.79	3.32	6.31	1.82	1.34	3.25	2.50	1.47	4.04	2.41	2.31	1.49	35.05
1900	4.86	8.20	8.05	2.08	4.46	3.50	2.44	2.41	3.06	3.99	6.41	2.79	52.25
1901	1.78	1.00	5.77	8.25	6.93	2.17	6.37	4.82	3.35	3.05	3.16	6.95	53.60
1902	2.62	5.23	4.02	3.72	1.53	2.78	3.03	2.93	4.82	4.70	1.42	6.41	43.21
1903	3.48	3.64	6.85	2.86	0.97	10.37	2.36	3.84	2.88	4.67	1.65	3.31	46.88
1904	4.95	2.00	2.96	8.55	1.99	2.44	2.49	4.40	5.21	1.37	1.80	3.05	41.21
1905	3.67	1.70	3.35	2.94	1.22	6.20	3.79	2.98	6.97	1.52	2.16	3.78	40.28
1906	3.12	3.06	5.92	2.79	6.57	3.82	3.88	4.88	3.59	3.61	2.96	3.75	47.95
1907	3.41	2.59	1.63	3.23	3.74	3.80	2.13	0.90	9.62	4.43	6.41	4.81	46.70
1908	4.06	5.85	4.01	2.11	5.36	0.78	3.94	4.93	0.98	2.43	0.99	2.72	38.16
1909	3.89	6.01	3.92	5.04	2.76	1.92	1.65	3.15	4.74	1.50	2.91	3.95	41.44
1910	5.22	3.10	1.60	2.42	1.22	4.23	1.67	3.78	2.62	1.51	4.56	2.17	34.10
1911	2.76	3.56	3.15	2.85	1.35	3.15	2.92	4.42	2.84	3.95	4.43	2.92	38.30
1912	2.91	2.35	6.46	4.37	5.28	0.49	2.49	2.89	1.22	2.48	3.76	4.47	39.17
1913	2.87	2.40	5.34	4.87	4.46	1.87	3.27	3.85	4.03	6.90	2.75	2.30	44.91
Av.	3.75	3.95	4.37	3.37	3.29	3.06	3.41	3.92	3.34	3.87	3.76	3.47	43.56

RAINFALL AT WESTFIELD, MASS. Elevation, 475 feet.

(West Parish Filters, Springfield Water Works.)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1906	2.45	1.40	5.61	4.26	4.81	2.69	4.86	3.74	3.12	4.27	3.41	2.95	43.57
1907	3.12	2.35	1.10	2.86	4.44	5.64	2.86	1.50	11.08	7.11	6.14	5.60	53.80
1908	1.79	5.67	1.92	4.08	6.67	3.43	5.13	4.42	1.43	2.25	0.40	3.43	40.62
1909	4.67	5.42	3.40	6.67	2.87	2.30	2.15	5.54	4.08	1.16	2.37	4.64	45.27
1910	7.37	6.26	0.51	1.80	2.60	4.35	1.50	3.46	3.75	0.95	4.58	1.73	38.86
1911	2.09	2.24	4.05	2.70	1.42	3.36	3.01	6.24	4.68	9.90	3.27	3.62	46.58
1912	2.30	2.99	5.69	5.63	4.48	0.71	2.71	4.26	3.37	5.57	4.42	4.43	46.56
1913	3.75	2.24	6.24	3.55	5.37	1.01	1.38	3.13	3.39	9.09	3.89	3.06	46.10
Av.	3.44	3.57	3.57	3.94	4.08	2.94	2.95	4.04	4.36	5.04	3.56	3.68	45.17

RAINFALL AT WESTON, MASS. Elevation, 60 feet.

(Stony Brook Reservoir, Cambridge Water Works.)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1890	3.01	2.86	7.43	3.73	5.65	2.33	2.66	4.43	5.78	8.89	1.28	5.17	53.22
1891	6.14	4.47	6.18	2.89	1.70	4.39	3.21	5.60	2.93	3.86	2.57	3.48	47.42
1892	4.71	2.45	4.08	0.89	5.35	3.91	2.16	5.27	1.99	1.58	5.30	1.11	38.80
1893	2.35	6.19	3.02	3.18	4.71	2.25	2.95	6.89	1.73	3.15	1.99	5.26	43.67
1894	3.63	3.46	1.07	3.20	3.66	0.47	3.27	1.33	2.17	5.25	2.89	4.58	34.98
1895	4.08	1.33	2.84	4.63	2.07	4.11	3.83	4.33	2.28	8.42	7.22	2.58	47.72
1896	2.34	5.96	5.47	1.79	2.03	2.68	2.87	2.79	6.81	3.18	3.27	1.58	40.77
1897	4.38	2.41	3.50	2.72	4.50	5.48	4.70	4.76	2.41	0.39	6.22	4.51	45.98
1898	4.28	4.98	2.11	5.37	3.46	1.88	4.29	6.62	1.90	7.11	6.58	3.10	51.68
1899	4.43	4.83	8.78	1.49	1.06	3.10	3.03	3.66	5.25	1.79	4.44	2.04	43.90
1900	5.41	10.31	5.55	2.08	4.86	2.98	2.66	2.25	4.85	3.63	4.67	2.52	51.77
1901	1.42	1.17	6.71	6.68	7.56	1.13	5.44	4.67	4.01	2.68	2.78	7.38	51.63
1902	1.88	4.12	6.38	3.94	1.30	2.32	3.84	3.56	4.32	4.48	1.06	5.68	42.88
1903	3.77	4.01	6.13	3.37	0.80	7.45	3.38	3.66	1.99	4.19	1.44	2.59	42.78
1904	4.46	3.08	2.60	9.48	2.51	2.64	2.01	2.87	5.70	1.67	1.57	2.94	41.53
1905	5.33	1.62	3.46	2.48	1.59	5.38	1.89	3.11	7.09	1.24	2.27	3.42	38.88
1906	2.56	2.83	6.16	2.39	4.52	2.18	4.87	2.33	2.71	2.86	2.91	4.51	40.83
1907	3.06	1.98	2.02	3.49	3.55	2.52	1.64	1.58	8.36	3.52	6.09	3.84	41.65
1908	3.53	4.83	3.67	1.48	4.28	1.25	3.56	3.97	0.87	2.61	1.05	2.50	33.60
1909	4.21	5.14	3.95	4.00	1.88	3.08	1.61	2.95	5.12	1.20	3.44	4.26	40.84
1910	4.98	3.88	1.53	2.32	1.05	4.25	2.20	1.18	2.88	1.58	4.21	2.26	32.32
1911	2.32	2.97	3.44	2.51	0.63	4.12	4.29	5.68	3.82	2.88	4.54	3.85	41.05
1912	2.70	2.61	6.00	4.16	5.05	0.26	4.27	2.84	1.88	2.56	3.16	5.26	40.75
1913	2.76	3.50	5.52	4.24	4.11	0.87	3.05	4.12	3.72	5.98	2.31	2.99	43.17
Av.	3.66	3.79	4.48	3.44	3.24	2.96	3.24	3.77	3.77	3.53	3.47	3.64	42.99

RAINFALL AT WESTON, MASS. Elevation, 120 feet.

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1897	...	...	...	...	...	...	...	...	...	...	6.00	4.41	....
1898	5.19	4.74	1.99	5.41	3.50	1.78	5.33	7.15	2.47	7.15	6.06	3.10	53.87
1899	4.30	3.75	6.69	1.50	1.18	3.35	2.98	2.54	4.84	2.11	2.59	1.51	37.34
1900	4.42	8.17	5.20	2.23	4.97	2.67	2.63	2.52	4.92	3.71	4.66	2.60	48.70
1901	1.49	1.61	6.30	7.02	8.28	1.12	5.76	3.87	3.20	2.78	2.76	7.81	52.00
1902	2.06	5.56	5.35	3.76	1.59	2.52	4.28	4.12	4.02	4.37	0.92	6.43	44.98
1903	3.78	4.26	6.30	3.45	0.81	7.93	4.35	3.92	2.11	4.37	1.51	2.63	45.42
1904	3.23	2.98	2.81	9.58	3.36	2.60	1.93	3.84	5.97	1.71	1.53	2.31	41.85
1905	5.05	2.16	2.79	2.86	2.15	4.38	2.02	2.81	7.99	1.30	2.17	3.83	39.51
1906	2.22	2.14	4.64	2.59	4.63	2.69	4.50	3.46	2.56	2.76	2.50	4.55	39.33
1907	2.88	2.13	1.72	2.30	...	...	...	...	...	...	...	...	....
Av.	3.53	3.93	4.67	4.27	3.39	3.23	3.76	3.80	4.23	3.36	2.75	3.86	44.78

RAINFALL AT WILLIAMSTOWN, MASS. Elevation, 711 feet.

(Williams College.)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1854	...	...	...	...	...	...	...	...	5.86	1.93	4.71	1.10	....
1855	2.52	1.43	0.21	5.64	2.85	5.48	6.75	3.56	1.92	12.93	4.59	6.63	54.51
1856	2.23	0.96	1.65	2.09	6.25	...	1.27	14.79	4.25	1.20	2.51	3.76	....
1857	...	3.68	...	...	...	...	4.05	5.19	3.32	4.87	1.76	3.86	....
1858	2.99	1.00	1.06	2.24	3.54	2.82	4.37	5.77	2.97	3.15	3.11	1.74	34.76
1859	7.33	1.74	4.62	3.88	...	...	3.46	2.56	3.78	1.31	3.04	5.05	....
1860	1.04	2.37	2.20	1.02	2.38	4.09	7.18	4.86	5.07	2.48	4.43	3.37	40.49
1861	1.02	2.92	4.41	5.32	5.25	2.08	6.09	4.14	3.82	4.15	3.17	2.13	44.50
1862	3.65	...	...	...	...	...	...	...	...	...	...	...	....
1863	...	...	...	...	...	1.53	9.87	5.24	3.05	2.32	4.26	4.13	....
1864	1.24	1.49	2.24	1.92	1.98	1.64	1.91	4.96	3.06	3.58	3.16	4.18	31.36
1865	...	1.04	5.29	4.10	...	2.93	4.83	0.65	2.27	5.27	1.79	2.12	....
1866	1.01	1.78	1.76	0.75	3.38	4.38	4.05	3.38	4.97	2.37	4.00	3.75	35.58
1867	1.65	2.35	1.38	3.96	5.90	1.47	3.61	5.21	2.20	1.27	3.39	1.55	33.94
1868	2.42	1.95	1.20	2.60	5.43	1.22	0.37	3.40	6.50	0.93	4.42	2.49	32.93
1869	3.52	3.78	4.44	3.16	3.28	3.84	5.17	...	3.18	10.68	1.09	4.41	....
1870	5.46	5.80	4.76	3.29	1.27	5.05	3.89	5.77	2.24	4.30	2.25	0.76	44.84
1871	1.12	1.50	3.02	2.29	2.19	4.85	4.72	6.53	1.00	2.00	2.74	3.61	35.57
1872	1.05	...	3.56	...	...	...	...	...	...	...	...	...	....
1873	...	...	...	...	...	...	...	...	...	...	...	...	....
1874	...	...	9.95	0.90	...	...	...	...	...	...	0.80	0.10	....
1875	...	...	...	...	...	3.51	3.94	5.06	3.49	5.26	3.84	1.44	....
1876	3.52	4.48	4.68	3.52	2.69	6.59	6.77	1.63	3.85	0.79	3.56	3.00	45.08
1877	...	0.22	4.64	1.29	...	4.22	...	...	...	...	...	...	....
1878	...	...	...	...	...	...	...	3.25	1.62	3.06	4.29	3.70	....
1879	2.00	1.86	2.37	3.04	...	...	...	3.93	4.62	0.93	3.43	2.59	....
1880	3.39	2.60	1.46	4.77	2.58	1.55	4.36	3.59	3.09	2.46	1.51	2.39	33.75
1881	1.88	6.19	2.28	...	3.53	2.08	5.16	1.02	2.26	2.28	3.33	5.04	....
1882	2.23	...	2.35	1.72	4.26	3.85	2.42	3.26	7.04	0.32	1.18	0.96	....
1883	...	2.64	0.87	1.98	3.81	3.19	4.59	2.92	2.64	3.32	1.65	...	....
1884	1.75	3.76	3.89	1.83	2.51	1.65	...	...	0.58	2.98	2.92	3.72	....
1885	6.63	3.56	0.96	3.18	2.00	1.48	2.87	6.66	1.65	3.12	3.97	3.43	39.51
1886	3.92	2.61	5.01	1.56	4.77	2.72	4.20	1.56	4.31	2.60	5.80	4.04	43.10
1887	6.29	4.50	5.15	3.23	1.31	4.33	10.82	7.03	2.30	1.13	3.77	4.30	54.16
1888	...	2.18	7.89	2.80	3.64	3.90	1.23	4.48	4.21	5.06	4.12	3.38	....
1889	2.96	1.22	1.10	2.31	1.78	5.08	5.81	2.94	2.39	2.95	4.20	3.30	36.04
1890	3.41	3.92	4.06	1.46	4.68	1.72	...	...	...	...	...	...	....
1891	...	...	...	...	...	...	5.43	4.48	0.74	1.80	1.80	3.59	....
1892	2.68	1.13	1.75	0.40	5.43	2.07	4.22	4.58	1.68	1.57	2.99	5.46	33.96
1893	2.72	3.72	1.39	2.43	2.75	2.08	1.46	5.84	4.46	2.26	1.22	5.94	36.27
1894	2.54	2.29	1.13	1.82	3.16	2.99	3.39	1.46	4.58	4.91	...	1.75	....
1895	1.87	1.70	2.10	3.90	2.10	3.62	2.37	3.25	2.22	3.74	4.12	3.11	34.10
1896	0.71	2.29	3.10	0.79	2.22	2.55	3.89	3.06	4.83	2.94	2.98	1.46	30.82
1897	2.62	1.37	2.93	3.50	4.21	6.61	9.74	3.40	2.12	0.86	6.46	4.61	48.43
1898	5.25	2.15	2.47	3.60	4.10	3.01	1.48	8.51	3.22	6.99	3.25	2.42	46.45
1899	1.61	2.31	4.05	1.58	1.06	3.66	5.03	1.60	5.31	1.11	1.30	2.29	30.91
1900	3.61	3.46	3.14	1.17	2.43	4.94	5.56	5.91	1.21	3.52	3.59	1.54	40.08
1901	1.69	0.48	4.58	5.76	4.98	1.80	5.78	7.14	1.98	1.91	2.46	4.63	43.19
1902	1.24	2.45	3.56	3.70	3.30	4.83	4.64	5.14	4.01	3.66	0.97	4.41	41.91

RAINFALL AT WILLIAMSTOWN, MASS. — *Continued.*

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1903	2.68	3.55	4.67	1.37	0.63	9.07	3.49	7.51	1.36	4.46	1.92	2.19	42.90
1904	1.96	0.94	1.51	2.22	3.24	5.29	1.60	4.34	5.39	2.56	1.68	1.39	32.12
1905	1.91	0.56	2.74	1.89	1.19	5.74	5.35	4.55	3.24	2.05	1.95	2.13	33.30
1906	1.36	1.89	2.33	2.93	5.40	3.55	5.50	2.77	1.63	3.18	2.45	3.09	36.08
1907	2.24	1.52	1.56	2.88	2.22	3.86	3.96	1.25	6.06	6.50	3.42	2.17	37.64
1908	0.95	2.29	2.03	2.85	5.19	3.24	4.98	3.91	0.38	1.74	0.83	2.09	30.48
1909	3.69	4.46	2.96	3.12	2.84	3.54	1.51	5.37	4.27	1.33	1.49	1.70	36.28
1910	3.90	3.14	1.02	2.53	5.06	3.03	2.61	2.01	5.68	2.03	3.61	2.32	36.94
1911	2.38	0.75	2.49	1.12	1.62	3.85	2.30	4.41	4.21	5.08	1.93	1.82	31.96
1912	2.00	1.23	3.28	4.12	4.83	1.62	2.69	3.64	2.35	4.55	2.44	3.59	36.34
1913	2.99	2.32	6.08	1.76	2.89	0.87	3.88	1.26	2.92	3.91	1.63	2.33	32.84
Av.	2.63	2.30	2.71	2.74	3.16	3.61	4.32	4.34	3.24	3.14	2.99	3.01	38.19

RAINFALL AT WINCHENDON, MASS. Elevation, 975 feet.

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1894	2.40	2.22	1.16	2.88	2.76	2.26	1.54	1.06	7.09	2.63	2.06	3.25	31.31
1895	2.90	0.68	2.17	4.34	1.93	2.72	4.58	4.14	3.43	4.19	5.46	3.60	40.14
1896	1.14	3.51	6.63	1.57	2.72	1.49	3.40	2.65	6.10	4.30	2.35	1.41	37.27
1897	3.71	2.15	3.67	2.33	4.06	5.34	10.25	5.62	1.78	0.82	6.40	5.01	51.14
1898	4.88	3.47	1.20	4.50	4.53	4.44	2.04	5.89	4.16	6.90	5.99	2.64	50.64
1899	2.77	3.05	5.61	1.23	1.39	5.73	5.93	2.91	4.57	1.62	2.25	2.00	39.06
1900	4.27	6.19	5.22	2.05	2.92	3.26	2.85	3.31	5.02	3.64	7.22	2.49	48.44
1901	1.49	0.85	4.78	5.08	6.15	1.61	4.53	5.06	2.65	3.52	2.27	7.98	45.97
1902	2.02	3.14	4.88	3.35	2.88	3.71	5.01	4.87	4.24	4.25	1.00	6.70	46.05
1903	2.70	3.73	6.15	2.35	1.29	8.18	6.05	3.36	1.95	2.86	2.03	3.48	44.13
1904	3.17	1.70	3.01	6.40	3.16	2.85	2.51	7.08	5.27	1.61	1.24	2.40	40.40
1905	4.01	1.46	2.88	2.02	0.89	8.37	3.63	5.14	6.07	1.63	2.66	3.12	41.88
1906	1.92	2.21	3.89	1.76	5.24	4.08	4.45	3.37	1.80	3.53	1.93	3.47	37.65
1907	2.50	1.30	1.56	2.22	3.29	2.78	5.69	1.73	8.36	4.77	4.32	2.59	41.11
1908	2.13	3.22	2.46	1.53	4.28	0.97	2.94	7.22	0.95	1.55	1.03	2.44	30.72
1909	3.94	5.13	3.03	5.07	2.59	2.80	2.66	3.51	4.09	1.19	2.23	2.47	38.71
1910	5.04	4.55	1.54	2.89	3.07	2.21	1.64	3.18	3.05	1.11	2.98	1.99	33.25
1911	2.37	2.00	3.69	1.85	0.75	2.24	2.62	5.88	3.12	7.40	3.37	3.01	38.30
1912	2.16	2.18	4.95	3.94	4.50	0.83	2.41	2.17	3.58	2.31	4.17	4.06	37.26
1913	2.62	2.87	5.47	3.14	4.12	1.02	0.98	3.26	3.39	4.49	2.44	3.21	37.01
Av.	2.91	2.78	3.70	3.02	3.13	3.34	3.79	4.07	4.03	3.21	3.17	3.37	40.52

RAINFALL AT WINCHESTER, MASS. Elevation, 90 feet.
(North Reservoir, Winchester Water Works.)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1880	2.61	4.23	2.49	2.18	2.02	1.49	7.24	3.63	1.43	2.69	1.91	2.50	34.42
1881	6.32	3.05	4.49	1.54	2.60	6.52	2.92	0.57	2.02	1.19	3.14	3.39	37.75
1882	3.93	6.39	2.66	2.13	4.58	2.06	2.77	1.05	8.45	1.45	1.76	2.26	39.49
1883	2.29	3.16	2.17	2.42	3.60	1.62	2.54	0.85	1.44	4.20	1.98	3.36	29.63
1884	5 04	4.97	4.30	3.12	3.00	2.05	3.41	5.07	1.28	2.51	1.98	4.69	41.42
1885	4 87	3.44	1.14	3.33	3.90	4.41	1.74	5.95	1.32	5.60	6.28	2.11	44 09
1886	6.40	7.20	3.72	1.91	2.78	1.56	3.70	3.48	3 04	2.78	4.06	4.99	45.62
1887	4.27	4.81	5.41	4.00	1.66	2.71	6.74	4.76	1.46	3.02	3.16	3.43	45.43
1888	3.80	3.25	4.53	2.82	4.96	2.21	2.26	6.72	7.79	4.73	6.30	4.94	54.31
1889	4.60	3.74	4.00	2.88	4.85	2.11	2.11	5.97	8.20	4.87	6.68	5.12	55.13
1890	2.60	3.39	6.21	2.49	6.41	3.42	2.27	3.56	3.50	8.39	1.41	4.32	47.97
1891	6.32	4.51	5.93	2 73	2.17	4.33	3.02	3.30	2.37	4.53	2.43	3.20	41.84
1892	4.49	3.03	3.76	0.74	4.88	4.26	1.54	4.49	1.61	0.91	4.10	1.10	34.91
1893	2.26	3.36	1.92	3.09	5.18	1.81	1.94	5.91	2.07	3.86	1.85	4.31	37.56
1894	3.23	2.73	0.96	2.60	4.24	0.31	3.14	1.24	1.97	4.93	3.58	4.18	33.11
1895	3.26	0.44	2.58	3.91	3.59	3.89	4.13	5.56	2.56	9.70	6.02	2.64	48.28
1896	1.98	3.84	7.14	1.56	1.89	2.18	2.00	2.32	7.99	3.01	2.51	2.18	38.60
1897	3.95	2.37	3.26	3.20	4.84	5.53	3.34	3.53	2.67	0.34	6.06	3.92	43.01
1898	4.51	3 38	2.17	5.76	4.55	1.64	4.39	8.23	2.30	7.62	6.06	3.89	54.50
1899	3.23	4.00	5.34	1.31	0.93	2.77	2.67	2.23	4.54	1.08	3 27	1.30	32.67
1900	4 61	8.08	4.68	2.00	4.49	2.16	1.87	2.23	2.53	3.00	4.64	2.11	42.40
1901	2.55	1.44	4.83	7.78	6.10	0.95	4.46	3.48	3.60	2.45	2.71	6.53	46.88
1902	2.14	5.28	6.18	4.07	0.58	1.92	2.37	3.43	2 45	4.95	1.19	5.91	40.47
1903	3.31	3.70	5.68	4.14	0.41	9.90	2.25	3.02	1.63	3.65	1.38	2.25	41.32
1904	4.59	2.60	1.74	8.47	3.18	3.04	1.51	3.19	5.10	1.69	1.58	2.22	38.91
1905	5.26	1.70	2.59	2.73	1.26	6.14	1.10	3.65	7.72	1.28	2.51	3.69	39.63
1906	2.88	2.76	9.27	2.55	5.15	2.95	5.22	2.57	2.02	2.69	2.83	5.90	46.79
Av.	3.90	3.74	4.04	3.17	3.47	3.11	3.06	3.70	3.45	3.60	3.38	3.57	42.19

RAINFALL AT WINCHESTER, MASS. Elevation, 20 feet.
(Wedgemere.)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1878	5.67	5.75	4.01	5.76	0.66	2.56	3.39	7.44	3.27	5.13	5.78	5.04	54.46
1879	1.87	2.76	3.68	4.75	1.80	4.05	2.31	5.58	1.65	0.76	2.80	3.78	35.79
1880	2.83	4.28	2.45	2.34	2.00	1.54	7.11	3.38	1.42	2.60	1.94	2.50	34.39
1881	5.52	3.65	6.68	1.44	3.07	6.75	2.69	0.73	2.31	2.17	3.57	3.31	41.89
1882	5.59	4.72	2.53	2.13	4.58	2.06	2.29	1.05	8.45	1.94	1.79	2.26	39.39
1883	2.69	3.05	2.19	2.42	3.55	1.64	2.84	0.88	1.47	5.52	1.98	3.36	31.59
1884	4.89	5.72	4.29	3.07	3.03	4.75	3.71	5.03	0.67	2.81	1.98	4.69	44.64
1885	4.87	3.44	1.14	3.33	3.90	4.41	1.80	5.95	1.32	5.60	6.28	2.11	44.15
1886	6.40	7.15	3.72	1.91	2.76	1.56	3.70	3.48	3.04	2.72	4.06	4.97	45.47
1887	5.27	4.51	4.96	4.69	1.63	2.70	6.74	4.76	1.46	3.02	3.16	3.43	46.33
1888	4.35	3.42	5.00	2.88	4.85	2.29	2.11	5.97	8.29	4.87	6.68	5.12	55.83
1889	5.13	1.82	2.21	3.59	4.56	3.27	8.10	4.18	4.61	3.47	5.06	2.80	48.80
1890	2.66	3.40	6.47	2.35	6.41	3.42	2.19	3.56	3.50	8.39	1.41	4.26	48.02
1891	6.20	5.17	5.95	2.80	2.37	4.33	3.20	3.66	2.01	4.53	2.43	3.20	45.85
1892	4.49	3.03	3.76	0.74	5.32	4.20	2.61	4.59	1.88	1.56	4.13	1.09	37.40
Av.	4.56	4.12	3.94	2.95	3.37	3.30	3.65	4.02	3.02	3.67	3.54	3.46	43.60

RAINFALL AT WINCHESTER, MASS. Elevation, 25 feet.
(Mystic Upper Lake Dam, Boston Water Works.)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1876	1.63	3.67	8.72	4.37	2.83	1.09	8.67	0.87	4.49	1.90	6.64	2.12	47.00
1877	3.07	0.76	6.72	3.45	3.17	1.69	2.30	5.94	0.39	7.61	7.11	0.89	43.10
1878	5.67	5.72	3.86	5.69	0.69	2.67	3.66	7.57	3.12	4.76	5.61	4.65	53.67
1879	1.77	2.69	3.37	4.54	1.92	3.92	2.46	5.39	1.55	0.77	2.73	3.70	34.81
1880	2.40	4.18	2.53	2.02	2.04	1.44	7.36	3.89	1.43	2.79	1.87	2.50	34.45
1881	6.13	3.60	6.70	1.64	2.90	6.92	2.52	0.60	2.04	2.14	3.48	3.26	41.93
1882	5.50	4.64	2.45	2.09	4.58	2.12	2.39	1.08	8.25	1.94	1.70	2.20	38.94
1883	2.65	3.08	2.25	2.52	3.62	1.63	2.73	0.86	1.52	5.38	1.98	2.63	30.85
1884	4.60	6.45	4.22	3.29	2.87	4.52	3.73	4.68	0.73	2.59	2.03	4.43	44.14
1885	4.79	3.36	1.21	3.56	3.99	4.41	2.28	5.85	1.53	5.44	6.34	2.09	44.85
1886	6.23	7.20	3.96	2.29	3.13	1.52	3.72	3.00	2.87	2.98	4.07	4.68	45.65
1887	5.22	4.43	5.04	4.52	1.75	2.69	6.43	5.17	1.54	3.06	2.94	3.72	46.51
1888	3.75	3.14	5.37	2.80	5.35	2.11	2.35	6.49	8.83	5.04	7.02	5.42	57.67
1889	5.88	1.90	2.36	3.63	4.72	3.36	8.81	3.66	4.80	3.71	6.24	2.92	51.99
1890	2.79	3.36	6.89	2.46	6.19	3.34	2.34	3.72	3.90	9.29	1.36	5.08	50.72
1891	6.29	4.98	6.19	3.50	2.55	4.53	3.16	4.10	2.31	4.94	2.78	3.62	48.95
1892	4.54	3.00	4.25	0.89	5.85	4.10	2.54	5.05	2.13	2.11	5.16	1.21	40.83
1893	2.26	7.50	2.55	3.37	6.26	2.10	2.04	5.41	2.01	4.10	2.25	4.35	44.20
1894	3.93	3.31	1.09	3.48	5.18	0.72	3.45	2.52	2.52	5.58	3.49	3.97	39.24
1895	3.84	0.88	3.15	4.46	2.71	3.51	4.66	5.31	2.23	9.24	7.95	1.96	49.90
1896	2.77	5.09	5.19	1.99	2.13	2.51	2.45	2.90	7.78	3.37	3.56	2.39	42.13
1897	3.81	2.62	3.34	3.11	5.05	5.82	4.24	3.35	3.26	0.44	6.74	4.80	46.58
1898	5.62	5.00	2.11	6.21	3.97	2.06	5.57	7.50	2.64	7.37	6.81	3.00	57.86
Av.	4.14	3.94	4.06	3.30	3.63	2.99	3.91	4.12	3.12	4.20	4.34	3.29	45.04

RAINFALL AT WORCESTER, MASS. Elevation, 400 feet.
(Worcester Sewage Disposal Works.)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1895	...	...	...	...	...	...	...	5.00	1.95	9.57	6.39	2.82	..
1896	1.18	5.80	4.35	0.94	2.43	2.76	3.01	2.92	7.24	3.26	2.52	1.91	38.32
1897	2.44	2.64	3.63	2.36	3.86	3.18	6.49	2.66	1.65	0.70	6.27	5.58	41.46
1898	4.80	4.15	2.17	3.49	2.22	2.10	2.99	7.34	3.52	7.03	6.68	2.95	49.44
1899	3.73	3.75	5.27	2.06	0.90	3.80	3.27	1.62	4.30	1.92	2.36	1.77	34.75
1900	4.35	8.10	6.13	2.54	3.84	4.65	2.80	3.20	2.27	1.85	4.69	2.05	46.47
1901	1.19	0.67	4.74	6.64	4.68	1.23	2.87	3.34	2.94	2.68	1.94	7.31	40.23
1902	2.11	4.13	5.08	4.44	1.50	3.94	4.30	3.21	3.22	5.92	1.12	5.97	41.97
1903	3.34	4.20	6.65	2.47	1.06	9.45	2.93	3.84	1.82	3.72	1.80	3.37	44.65
1904	3.61	2.29	3.00	7.44	2.16	2.25	2.97	4.32	5.48	1.11	1.56	2.38	38.57
1905	4.45	2.05	3.08	2.70	1.58	5.43	2.64	2.73	6.43	1.80	2.63	3.44	38.96
1906	2.54	2.60	5.45	2.82	5.75	4.14	8.20	2.12	2.89	3.97	2.65	3.80	46.93
1907	2.76	1.84	1.69	2.72	2.92	3.82	2.55	1.08	9.38	4.63	6.06	4.53	43.98
1908	3.28	4.14	3.78	2.12	4.78	1.17	3.16	6.24	1.44	1.92	0.96	3.00	35.99
1909	2.91	5.66	4.13	5.48	2.57	2.21	0.97	2.96	3.96	1.11	2.18	3.51	37.65
1910	5.75	1.38	0.94	2.77	1.55	4.00	2.23	3.20	2.78	1.23	3.51	2.05	34.39
1911	2.76	2.28	3.50	2.61	2.11	2.00	2.43	4.56	3.67	4.60	4.59	3.17	38.28
1912	2.18	2.74	6.24	4.18	5.32	0.18	2.76	3.37	1.45	1.41	4.46	4.92	39.21
1913	2.97	3.04	5.10	4.61	4.15	1.36	2.59	2.54	3.77	6.35	2.48	3.05	42.01
Av.	3.13	3.58	4.16	3.47	2.96	3.20	3.29	3.40	3.79	3.07	3.25	3.60	40.90

RAINFALL AT WORCESTER, MASS. Elevation, 600 feet.
(Worcester Insane Hospital.)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1841	4.78	0.83	3.43	6.54	3.46	0.92	2.94	2.97	4.27	3.84	4.17	4.77	42.92
1842	1.35	4.13	2.24	2.82	3.24	4.93	1.96	7.12	3.50	0.83	3.36	5.30	40.78
1843	5.05	4.45	5.23	3.13	1.73	4.15	3.39	9.19	1.25	5.19	3.63	2.28	48.67
1844	3.14	1.44	3.80	0.35	3.67	1.92	3.50	3.39	3.68	7.34	3.06	2.56	37.85
1845	4.17	2.61	3.29	1.61	3.23	3.14	2.91	2.36	2.57	4.44	6.77	5.39	42.49
1846	2.92	2.50	3.33	1.34	5.85	2.37	3.81	2.44	0.90	2.19	4.08	2.87	34.60
1847	4.66	4.08	3.89	1.67	3.52	5.29	4.86	4.20	7.17	2.87	3.75	4.93	50.89
1848	3.08	1.61	3.89	1.52	6.82	1.31	3.13	3.19	2.36	5.75	1.94	3.93	38.53
1849	0.98	1.30	4.75	1.95	3.56	1.25	1.60	4.28	2.49	6.45	4.11	3.12	35.84
1850	4.79	3.23	3.67	5.53	7.50	3.25	3.75	6.05	7.92	3.37	2.14	4.19	55.39
1851	2.07	4.01	1.40	6.76	4.73	3.16	2.17	1.97	2.59	7.04	5.68	2.30	43.88
1852	5.44	2.46	3.42	10.77	3.15	3.53	3.42	11.38	3.36	3.89	5.88	4.78	61.48
1853	3.04	8.09	3.60	4.92	5.45	1.01	3.29	10.71	5.26	6.20	5.30	3.79	60.66
1854	2.82	6.62	3.45	6.69	6.78	3.05	5.68	0.35	5.53	5.03	9.82	3.34	59.16
1855	8.11	4.48	0.23	5.39	1.64	4.19	9.40	4.06	0.20	8.17	5.85	6.90	58.62
1856	4.60	1.35	1.69	3.34	6.55	1.44	2.68	13.14	3.39	2.65	2.03	4.08	46.94
1857	4.48	2.24	2.80	8.77	4.56	3.44	3.80	5.75	4.92	3.93	3.12	6.11	53.92
1858	3.06	1.10	2.29	4.14	4.13	5.16	4.18	4.00	5.70	3.09	1.69	3.19	41.73
1859	5.75	3.67	7.71	2.90	3.65	5.17	1.26	5.45	4.00	2.46	3.00	4.55	49.57
1860	1.34	2.77	2.26	1.36	2.66	6.65	7.91	5.76	6.02	2.47	4.38	5.05	48.63
1861	4.33	1.60	2.85	5.71	3.50	2.46	5.29	3.99	3.11	3.38	3.93	1.81	41.96
1862	4.47	2.44	3.51	2.34	1.87	7.44	6.10	2.64	2.14	3.22	5.35	2.50	44.02
1863	4.09	3.42	5.78	5.28	1.76	1.18	8.87	3.96	2.56	4.85	4.77	4.41	50.93
1864	4.54	1.74	3.90	5.66	5.96	2.40	1.68	3.11	2.93	4.29	4.81	3.67	44.69
1865	3.92	3.26	4.72	2.51	5.33	1.72	3.37	3.39	0.68	0.51	2.36	2.75	34.52
1866	2.56	5.27	3.18	2.09	5.33	3.40	3.78	3.22	4.77	2.37	2.51	3.73	42.21
1867	5.16	4.42	4.40	2.50	4.91	3.32	3.36	10.79	1.97	3.79	2.19	2.07	48.88
1868	3.27	1.53	2.82	5.18	8.30	3.08	1.08	3.57	8.60	1.14	4.24	1.85	44.66
1869	2.82	5.49	1.83	2.52	5.77	3.08	1.40	2.21	4.74	9.81	2.43	5.25	50.35
1870	6.34	3.04	2.34	6.03	2.40	2.09	2.39	1.74	1.40	5.89	3.48	4.10	41.24
1871	4.53	4.36	4.68	3.68	3.70	5.39	3.70	3.94	0.90	5.31	4.57	1.15	45.91
Av.	3.92	3.21	3.53	4.03	4.35	3.25	3.76	4.85	3.58	4.25	4.01	3.77	46.51

RHODE ISLAND.

RAINFALL AT BLOCK ISLAND, R. I. Elevation, 26 feet.

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1881	2.16	4.74	5.08	1.91	5.51	12.93	1.61	4.30	3.78	5.29	6.47	5.66	59.44
1882	8.57	9.73	5.39	4.83	5.51	2.86	3.62	1.48	5.96	3.87	2.26	3.57	57.65
1883	3.95	4.09	2.47	3.49	2.89	1.54	3.53	1.74	2.60	7.38	3.16	2.85	39.69
1884	6.43	7.31	6.40	4.10	6.39	2.59	6.52	6.41	0.62	3.89	5.93	6.56	63.15
1885	5.30	3.68	0.81	2.65	4.14	1.90	0.86	3.15	1.60	5.81	4.79	4.68	39.37
1886	7.04	8.89	5.42	3.26	4.14	2.15	1.68	2.47	2.90	4.71	5.16	6.70	54.52
1887	6.98	7.02	4.49	3.49	0.51	2.75	7.52	3.13	2.00	2.28	1.68	2.70	44.55
1888	2.12	1.14	2.80	1.35	3.54	0.62	1.03	1.32	5.49	2.37	4.17	1.23	27.18
1889	2.16	1.57	2.30	2.10	3.21	2.84	2.92	3.37	3.41	3.11	4.86	0.95	32.80
1890	2.33	1.50	5.16	3.37	3.83	1.35	1.39	2.09	2.69	4.57	0.66	2.57	31.51
1891	4.25	3.97	2.42	2.81	2.14	1.83	3.38	3.51	1.69	7.33	2.89	2.81	39.03
1892	4.19	1.35	4.93	2.79	4.27	1.43	2.45	5.71	3.77	2.12	8.31	1.74	43.06
1893	2.65	6.06	5.73	5.45	4.92	1.61	0.97	5.41	2.58	2.75	2.16	4.55	44.84
1894	3.16	4.43	2.15	3.89	3.36	0.51	0.22	1.53	2.03	6.15	4.81	5.22	37.46
1895	4.12	1.13	4.76	6.15	4.08	1.80	8.57	4.27	1.46	4.62	5.81	2.44	49.21

RAINFALL AT BLOCK ISLAND, R. I. — *Continued.*

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1896	2.02	4.85	5.14	1.73	3.95	3.27	3.51	2.08	7.76	5.26	2.47	2.55	44.59
1897	3.93	2.83	3.06	5.70	4.31	3.06	5.08	3.41	3.95	1.83	9.42	5.61	52.19
1898	5.42	5.20	3.89	5.66	6.54	0.92	7.87	7.69	0.96	7.18	7.55	3.22	62.10
1899	5.18	4.96	8.54	2.13	2.09	2.48	4.49	1.79	4.92	2.23	1.04	1.46	41.31
1900	3.86	4.48	3.92	2.63	3.43	1.24	2.27	2.85	2.26	3.50	4.66	2.47	37.57
1901	1.95	0.83	5.60	6.53	5.93	2.56	1.24	3.82	4.07	3.44	2.62	8.67	47.26
1902	1.67	6.15	6.33	3.29	1.04	5.35	2.31	1.42	3.96	4.70	1.77	7.64	45.63
1903	4.42	4.61	8.03	5.61	0.86	4.82	1.90	4.33	1.15	2.66	2.77	2.45	43.61
1904	2.54	3.12	1.59	5.31	2 40	3.67	2.14	6.80	1.29	1.86	2.11	2.93	35.76
1905	2.46	1.39	2.19	2.10	2.35	5.16	2.59	4.83	4.79	1.37	2.28	4.03	35.54
1906	3.03	4.39	5.71	2.03	5.03	1.90	3.88	1.84	2.08	2.69	2.46	3.51	38.55
1907	3.37	2.20	2.80	2.69	4.95	1.81	1.74	1.28	4.84	2.19	6.35	5.68	39.90
1908	2.80	3.53	3.28	2.62	4.76	2.02	2.34	3.34	0.77	5.17	1.20	4.62	36.45
1909	3.95	5.70	2.60	7.97	3.26	1.43	0.93	1.71	3.68	1.74	3.15	3.10	39.22
1910	4.86	4.22	1.58	1.24	3.36	2.82	1.73	2.34	1.21	2.37	5.58	2.50	33.81
1911	3.19	2.01	3.16	4.50	1.08	1.57	2.95	9.79	2.03	3.94	6.06	2.98	43.26
1912	3.29	2.47	7.65	3.85	4.43	0.21	7.17	3.18	1.80	1.14	3.18	5.66	44.03
1913	5.25	3.90	2.88	4.91	1.65	0.73	1.23	2.36	3.09	4.06	2.24	3.50	35.80
Av.	3.90	4.04	4.19	3.70	3.63	2.54	3.08	3.48	2.95	3.74	3.94	3.84	43.03

RAINFALL AT BRISTOL, R. I. Elevation, 53 feet.

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1887	6.59	4.77	3.97	3.70	2.06	3.57	3.72	4.55	1.50	2.64	2.34	4.21	43.62
1888	4.15	3.11	7.14	2.15	5.41	1.32	3.02	5.26	6.74	2.74	6.76	2.95	50.75
1889	5.82	2.35	2.13	3.36	5.40	2.59	6.63	5.40	4.41	4.99	6.01	1.39	50.48
1890	2.43	2.51	8.14	3.54	5.48	5.17	1.66	3.87	4.00	8.20	0.85	4.95	50.80
1891	8.06	6.29	5.12	3.87	1.93	1.25	2.29	2.26	1.82	3.68	2.52	3.19	42.28
1892	5.08	1.46	4.27	1.72	4.40	2.23	1.45	4.18	2.78	1.15	5.67	1.37	35.76
1893	2.20	6.83	3.17	2.83	3.65	2.26	1.48	4.78	3.14	3.24	2.70	5.17	41.45
1894	3.58	3.75	1.10	4.30	3.85	1.05	2.22	1.57	2.94	6.82	4.14	5.21	40.53
1895	3.69	0.51	3.83	6.30	4.11	3.06	2.98	2.54	1.21	5.22	5.26	3.10	41.81
1896	1.91	4.11	5.22	1.27	2.86	3.61	2.88	3.19	7.34	3.14	3.33	1.39	40.25
1897	3.76	2.49	2.77	4.03	4.28	2.08	5.33	5.02	1.85	1.22	7.57	5.35	45 75
1898	5.13	6.60	3.37	4.94	4.71	1.29	5.39	6.29	1.58	9.47	7.31	1.89	57.97
1899	5.54	5.08	7.06	2.00	2.38	3.60	3.21	1.74	7.78	1.58	1.93	1.29	43.19
1900	3.81	5.32	4.79	2.01	3.84	1.69	2.67	2.07	3.72	3.59	3.42	2.09	39.02
1901	1.21	0.55	5.52	5.88	7.14	1.21	3.89	2.56	2.69	2.64	1.77	9.16	44.22
1902	1.64	5.61	5.32	3.82	1.14	3.44	2.14	0.66	2.23	4.06	1.58	6.29	37.93
1903	4.75	5.38	6.90	4.43	1.69	6.08	2.08	3.52	0.84	2.91	1.98	3.08	43.64
1904	4.56	3.20	2.21	8.33	3.01	3.82	1.73	2.78	2.23	1.68	2.08	3.82	39.45
1905	3.28	2.25	2.67	2.55	1.45	5.46	2.77	3.90	4.76	1.95	2.13	3.82	36.99
1906	3.38	3.74	6.13	2.65	4.03	4.40	3.20	2.19	2.38	4.12	2.27	4.18	42.67
1907	3.17	3.86	1.99	2.13	4.14	1.31	0.95	1.41	6.19	2.41	5.37	5.38	38.31
1908	2.71	3.36	3 36	1.54	3.82	2.12	2.43	5.35	0.81	4.94	1.16	3.96	35.56
1909	5.53	5.67	3.04	5.73	2.70	1.43	0.58	2.40	4.32	1.54	3.46	3.23	39.63
1910	5.18	5.07	1.21	1.90	2.76	4.80	3.63	2 58	2.49	1.71	4.23	2.36	37.92
1911	3.08	2.33	2.79	3.73	1.24	1.79	4.36	3.96	1.46	2.66	6.85	3.65	37.90
1912	4.28	2.94	8.04	3.98	3.67	0.43	2.02	3.04	2.18	1.81	3.79	6.14	42.32
1913	4.18	2.61	3.57	6.71	1.72	1.09	2.69	2.66	2.59	7.75	1.82	3.98	41.37
Av.	4.03	3.77	4.25	3.68	3.44	2.67	2.87	3.32	3.19	3.62	3.64	3.80	42.28

RAINFALL AT BURRILLVILLE, R. I. Elevation, 400 feet.

(Wallum Pond.)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1910	5.50	2.86	1.00	1.35	2.04	4.73	1.75	1.77	1.70	2.08	2.88	2.60	30.26
1911	3.99	2.75	3.77	2.70	1.20	1.72	3.72	6.27	3.27	3.70	5.39	2.95	41.43
1912	2.65	2.85	8.10	4.57	4.43	0.46	4.67	5.19	2.44	2.39	4.32	6.66	48.73
1913	4.60	3.19	6.95	5.16	3.35	2.27	1.93	3.19	2.93	5.98	2.98	1.68	44.21
Av.	4.18	2.91	4.96	3.44	2.76	2.29	3.02	4.11	2.59	3.54	3.89	3.47	41.16

RAINFALL AT GREENE, R. I. Elevation, 450 feet.

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1910	5.38	4.17	0.99	2.48	3.07	3.00	2.04	3.02	3.91	1.43	4.81	2.71	37.01
1911	2.85	2.22	2.79	2.76	0.75	2.03	2.79	5.25	2.29	3.46	6.31	3.00	36.50
1912	2.93	2.58	7.08	4.51	4.66	0.64	2.26	3.44	3.02	1.85	4.02	6.52	43.51
1913	3.28	3.90	5.70	6.40	2.20	1.45	2.29	2.35	3.23	6.23	2.54	3.63	43.20
Av.	3.61	3.22	4.14	4.04	2.67	1.78	2.35	3.51	3.11	3.24	4.42	3.96	40.05

RAINFALL AT HOPKINTON, R. I. Elevation, 120 feet.

(Hope Valley.)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1910	6.00	4.95	1.44	2.06	3.09	4.20	3.32	3.27	2.21	1.99	4.28	3.45	40.26
1911	4.55	2.77	4.01	4.19	1.95	3.31	2.61	4.86	2.05	4.35	8.48	4.54	47.67
1912	4.77	2.91	9.23	4.98	4.53	0.62	3.06	3.09	2.14	1.80	4.58	6.82	48.53
1913	4.71	3.77	4.98	7.84	2.41	1.73	3.35	3.35	2.87	7.30	2.33	5.18	49.82
Av.	5.01	3.60	4.92	4.77	2.99	2.46	3.08	3.64	2.32	3.86	4.92	5.00	46.57

RAINFALL AT KINGSTON, R. I. Elevation, 250 feet.

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1889	8.27	2.92	4.70	4.14	6.06	4.25	8.70	5.50	5.52	5.18	7.38	2.91	65.53
1890	2.99	3.54	8.45	4.28	5.33	4.00	2.33	4.01	5.48	10.04	0.96	6.16	57.57
1891	8.45	7.20	6.96	4.20	2.43	1.12	2.29	2.25	2.11	6.12	2.83	3.99	49.95
1892	5.58	1.87	5.22	3.35	5.39	2.23	2.78	3.18	2.58	1.51	7.01	1.93	42.63
1893	3.14	9.44	6.47	5.98	6.12	3.92	0.95	5.84	3.76	3.02	3.37	5.52	57.53
1894	4.63	4.95	1.93	4.07	4.50	0.50	1.35	2.74	3.96	9.14	5.26	5.66	48.69
1895	4.94	1.75	4.00	6.54	4.28	3.83	5.36	2.70	1.29	7.89	4.25	2.45	49.28
1896	2.59	6.37	4.49	1.45	2.92	5.01	3.11	3.67	7.44	4.20	4.52	2.17	47.94
1897	5.19	2.73	3.96	4.81	3.95	4.43	6.35	4 31	1.76	0.89	10.25	6.25	54.88
1898	6.83	8.13	3.71	5.56	8.95	0.77	7.11	6.85	2.11	12.05	7.44	2.71	72.22
1899	5.66	5.08	9.67	2.63	1.88	1.87	2.71	6.00	7.26	2.43	2.70	1.80	49.69
1900	5.14	7.19	5.77	3.67	5.02	1.21	2.13	2 17	3.04	3.66	5.02	3.22	47.24
1901	2.44	1.13	8.58	8.78	6.98	1.32	4.05	1.98	4 05	2.93	3 04	10.30	55.58
1902	2.62	6.46	7.29	4.93	1.34	4.15	3.23	1.69	4 05	4.26	2.12	8 03	50.17
1903	5.50	7.04	9.19	6.91	0 70	6.55	3.59	6 55	0.75	3.05	2.50	3.77	56.10

RAINFALL AT KINGSTON, R. I. — *Continued.*

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1904	5.45	4.21	2.88	9.70	3.17	4.44	2.47	7.63	1.97	2.30	3.15	4.97	52.34
1905	4.37	2.18	2.86	2.83	1.69	5.22	3.71	4.66	5.86	1.75	4.23	5.56	44.92
1906	5.16	4.71	6.34	3.72	4.56	3.16	4.05	1.02	4.28	5.68	3.48	5.82	51.98
1907	4.11	3.75	3.19	4.04	5.64	2.95	0.72	1.49	6.89	3.06	8.03	7.99	51.86
1908	3.61	5.66	4.38	2.72	5.89	3.31	1.81	6.77	0.97	4.27	1.45	5.07	45.91
1909	6.44	6.68	3.38	6.56	4.92	2.93	1.51	2.39	4.62	2.28	3.97	4.04	49.72
1910	7.03	5.13	1.62	2.02	3.81	5.29	2.95	3.96	2.67	2.09	5.47	3.10	45.14
1911	4.88	2.36	4.04	4.96	1.97	3.26	3.71	6.24	2.31	5 01	8.99	4.80	52.53
1912	4.29	3.78	9.59	4.61	4.89	0.80	2.93	4.62	2.87	2.13	4.50	6.87	51.88
1913	4.70	3.40	4.83	7.49	2.51	1.45	2.94	3.65	3.12	7.29	2.48	5.64	49.50
Av.	4.96	4.71	5.34	4.80	4.19	3.12	3.31	4.07	3.63	4.49	4.58	4.83	52.03

RAINFALL AT NARRAGANSETT PIER, R. I. Elevation, 22 feet.

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1882	...	...	...	3.53	2.90	2.54	1.68	0.82	5.77	4.22	1.99	3.24	....
1883	4.92	4.24	2.91	2.76	2.55	2.03	6.09	1.13	1.80	8.14	5.11	2.75	44.43
1884	6.05	5.80	5.24	3.35	4.69	4.22	6.68	6.60	0.76	2.20	4.41	6.34	56.34
1885	5.72	1.75	1.02	2.67	3.49	1.58	0.63	6.90	1.39	5.97	2.34	2.25	35.71
1886	5.64	10.64	5.14	3.82	3.55	1.77	3.38	3.51	3.03	3.95	4.02	5.26	53.71
1887	6.73	6.28	4.15	4.01	1.05	4.35	4.16	3.33	3.14	3.03	2.47	4.94	47.64
1888	5.33	2.92	7.87	2.56	7.29	0.66	1.97	4.35	7.55	2.98	7.05	3.13	53.66
1889	6.52	3.03	3.66	3.46	5.49	4.35	7.32	5.27	3.79	5.23	7.18	2.29	57.59
1890	3.13	3.22	8.41	4.53	5.30	3.42	2.85	4.73	4.65	9.07	0.81	5.09	55.21
1891	8.57	6.78	6.12	3.22	2.20	1.26	1.38	2.00	1.22	5.24	2.49	3.98	44.46
1892	6.60	1.38	4.99	2.88	4.63	2.44	1.66	5.00	3.58	1.61	7.44	1.74	43.95
1893	2.97	6.61	4.22	4.85	5.31	2.57	0.82	4.85	3.42	2.80	2.72	5.08	46.22
1894	2.41	4.68	1.97	2.47	3.69	0.88	0.71	2.62	2.40	8.11	4.83	3.89	38.66
1895	4.67	1.26	4.11	6.61	4.58	3.76	4.97	2.92	2.11	4.15	5.09	2.14	46.37
1896	1.59	4.55	4.53	1.38	3.35	3.36	2.15	3.97	6.30	3.29	2.62	1.56	38.65
1897	4.15	3.02	2.94	4.10	3.63	2.56	5.44	6.95	2.50	1.23	8.25	6.70	51.47
1898	4.93	7.42	3.75	5.13	8.96	0.10	3.49	3.72	1.99	9.16	6.84	2.61	58.10
1899	6.04	3.25	8.13	2.57	2.57	1.50	3.79	4.02	6.30	2.23	1.29	1.40	43.09
1900	4.23	5.52	4.27	3.15	4.16	0.75	2.22	0.96	2.79	3.34	3.55	2.20	37.14
1901	2.29	1.17	7.03	6.73	6.55	1.74	2.15	2.84	3.17	2.64	2.79	9.33	48.43
1902	1.92	7.01	6.18	3.37	1.01	3.60	3.25	1.81	3.77	4.54	1.59	6.37	44.42
1903	4.27	5.19	8.95	6.05	0.80	6.22	2.29	4.55	0.84	2.41	2.31	3.56	47.44
1904	3.40	2.73	2.06	7.69	4.20	3.63	2.77	5.89	2.18	1.75	2.88	3.50	42.68
1905	2.96	1.26	2.67	2.43	2.11	5.04	2.75	4.99	5.35	2.03	3.36	3.94	38.89
1906	2 52	2.48	5.49	3.01	5.14	3.64	4.42	0.91	5 42	4.40	3.46	4.22	45.11
1907	3.80	2.02	2.56	3.69	4.93	1.99	0.87	0.94	7.99	2.70	6 38	5.69	43.56
1908	3.03	3.81	3.85	2.64	4.19	3.96	2 78	7.27	1.08	5.21	1.84	4.70	44.39
1909	5.07	6.68	2.71	6.35	4.06	2.02	1.16	2 16	3.85	2.03	4.36	2.65	43.10
1910	5.57	4.41	1.52	1.81	3.32	3.64	2.72	2.58	2.28	2.08	4.45	3.37	37.75
1911	4.09	2.32	3.87	4.29	1.68	2.41	3.63	7.43	3.26	3.44	7.92	3 69	48 03
1912	3.66	3.12	8.86	5.09	3.73	0.92	3.60	3.39	3 11	1.62	4.18	6.84	48.12
1913	4.65	4.42	3.89	6 66	2.75	1.27	2.29	3.05	3.08	7.18	2.99	4.52	46 75
Av.	4.43	4.16	4.62	3.98	3.90	2.63	3.04	3.89	3.36	3.99	4.10	4.06	46.16

RAINFALL AT NEWPORT, R. I. Elevation, 30 feet.

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1871	1.97	2.19	4.07	2.27	2.82	3.15	1.91	8.16	1.39	5.83	4.15	1.79	39.70
1872	2.07	1.06	2.10	1.52	3.23	1.48	5.83	3.70	3.89	4.06	3.62	1.46	34.02
1873	5.79	2.43	1.84	4.09	3.85	0.58	1.41	4.00	2 48	4.92	4.89	4 24	40.52
1874	3.20	2.77	1.41	6.99	3.99	3.71	...	...	...	...	...	....	....
1875	...	...	...	...	...	...	...	5.26	2.91	4.35	6.64	1.23	....
1876	1.59	6.18	8.47	5.78	2.73	1.32	4.92	0.82	4.90	1.88	7.98	3.75	50.32
1877	3.00	1.45	10.02	3.47	1.96	3.63	5.49	3.90	0.68	6.89	6.74	1.23	48.46
1878	7.06	3.21	5.77	6.87	4.54	3.46	2.37	4.15	1.71	5.19	7.99	7.78	60.10
1879	3.20	2.28	6.18	6.22	1.46	3.67	3.97	5.39	2.60	1.03	3.54	4.74	44.28
1880	2.14	3.65	5.93	4.69	1.12	1.95	5.86	7.15	2 80	3.59	4.01	4.87	47.76
Av.	3.35	2.81	5.55	4.36	2.71	2.41	3.97	4.66	2.56	4.17	5.36	3.73	45.64

RAINFALL AT NEWPORT, R. I. Elevation, 30 feet.
(Fort Adams.)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1871	1.97	2.19	4.07	2.27	2.82	3.15	1.91	8.16	1.39	5.83	4.15	1.79	39.70
1872	2.07	1.06	2.10	1.52	3.23	1.48	5.83	3.70	3.89	4.06	3.62	1.46	34.02
1873	5.79	2.43	1.84	4.09	3.85	0.58	1.41	4.00	2.48	4.92	4.89	4.24	40.52
1874	3.20	2.77	1.41	6.99	3.99	3.71	2.35	7.65	2.60	1.13	2.56	....	....
1875	3.39	2.80	4.26	3.37	...	6.06	3.34	4.12	2.34	3.12	4.26	0.68	....
1876	0.78	3.93	5.03	2.91	2.29	1.04	5.01	0.56	2.82	0.98	6.03	3.30	34.68
1877	1.87	1.15	5 32	2.81	1.53	3.70	4.32	3.96	0.32	6.83	4.75	0.70	37.26
1878	3.61	1.84	2.90	4.58	2.92	2.91	1.47	3.74	1.26	3.20	4.74	3.72	36.89
1879	2.49	0.76	4.30	4.13	1.16	2.90	1.84	4.22	2.15	0.70	1.98	3.40	30 03
1880	1.13	1.27	3.71	2.32	0.28	1.69	6.16	6.03	2.41	2.56	2.61	1.12	31.29
Av.	2.46	1.83	3.66	3.08	2.26	2.18	3.49	4.30	2.09	3.63	4.10	2.47	35.55

RAINFALL AT PAWTUCKET, R. I. Elevation, 90 feet.
(Pumping Station, Board of Public Works.)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1884	...	...	...	...	3.66	8.61	3.51	5.73	1.23	2.86	4.43	7.07	...
1885	4.66	3.30	1.26	2.80	3.91	2.64	1.67	5.03	0.80	5.67	3.85	3.16	38.75
1886	6.80	11.18	3.44	2.45	3.69	1.31	3.02	3.04	2.72	3.27	4.05	4.89	49.86
1887	5.36	6.16	4.56	4.31	2.74	4.38	6.51	5.52	1.56	2.48	1.96	4.24	49.81
1888	5.00	4.70	7.09	2.78	7.32	1.48	1.66	7.53	8.81	5.76	8.56	5.22	65.91
1889	5.72	2.40	1.16	4.41	5.67	3.02	10.68	5.97	4.78	5.01	6.85	2.92	58.59
1890	3.01	3.33	5.23	3.81	6.45	2.84	1.25	3.16	4.98	9.18	0.74	5.06	49.04
1891	6.57	5.40	5.41	3.34	2.16	4 00	3.52	4.95	2.43	4.22	2.40	3.77	48.17
1892	4.43	1.74	3.98	1.28	5.72	3.48	2.16	3.86	1.80	1.64	4.96	1.21	36.26
1893	2.18	5.82	5.14	3.97	5.90	2.39	0.96	4.06	2.54	3.47	2.52	4.81	43.76
1894	3.49	3.81	1.19	3.31	4.87	0.40	3.74	1.84	3.14	7.30	3.54	5.31	41.97
1895	5.29	1.40	3.14	6.02	3.21	2.49	5.33	2.40	2.43	5.89	8.56	2.01	48.17
1896	1.84	3.91	6.44	1.17	2.33	3.49	1.55	3.13	7.81	2.90	3.34	2.05	39.96
1897	5.45	3.15	2.79	3.31	4.77	4.12	5.62	3.82	1.93	0.65	6.52	5.40	47.53
1898	3.89	6.53	2.73	5.64	3.93	1.11	9.29	6.63	2.41	7.76	7.04	2.19	59.15
1899	5.05	5.20	7.60	4.48	2.03	3.55	4.80	1.72	8.98	1.10	2.82	2.56	49.89
1900	4.72	8.66	5.56	1.73	6.34	2.54	2.60	2.35	4.17	3.24	4.07	2.60	48.58
1901	2.10	1.21	7.67	7.04	7.11	0.86	2.83	2.40	4.04	3.13	2.31	8.57	49.27
1902	2.06	6.50	5.93	3.02	1.08	4.75	3.94	2.28	3.87	4.29	1.18	7.80	46.70
1903	5.51	6.03	7.28	3 79	0.43	6 34	4 61	4 14	0 91	3 68	1 60	5 49	49.81

RAINFALL AT PAWTUCKET, R. I. — *Continued.*

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1904	7.93	8.38	4.33	8.77	2.49	2.89	3.09	9.01	8.00	2.67	2.25	4.77	64.58
1905	4.23	2.61	2.46	4.20	1.77	5.63	1.45	5.12	6.59	1.90	1.78	5.92	43.66
1906	3.83	4.15	5.18	2.72	6.11	4.17	6.02	3.22	3.94	4.66	2.22	5.13	51.35
1907	3.60	3.66	2.46	3.99	3.50	3.10	1.92	1.00	9.16	3.54	6.18	6.00	48.11
1908	4.70	4.55	3.94	1.74	5.45	2.39	5.34	4.63	1.08	3.56	0.99	3.49	41.86
1909	3.36	6.03	3.55	5.59	1.95	1.76	1.26	2.34	3.39	1.25	4.00	3.93	38.41
1910	5.42	4.22	1.25	1.85	2.10	3.35	1.95	2.33	2.58	1.50	4.05	2.66	33.26
1911	2.88	2.61	3.40	2.83	2.06	1.92	3.77	5.69	2.01	2.98	6.30	3.39	39.84
1912	3.48	2.90	6.91	3.73	3.89	0.40	2.58	5.12	1.85	2.95	3.10	6.64	43.55
1913	3.05	3.20	5.41	5.03	2.07	1.51	4.05	3.36	2.62	6.19	2.38	3.89	42.76
Av.	4.33	4.58	4.36	3.76	3.83	2.84	3.69	3.99	3.84	3.86	3.80	4.31	47.19

RAINFALL AT PAWTUCKET, R. I. Elevation, 220 feet.
(Diamond Hill Reservoir, Board of Public Works.)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1901	1.75	0.79	8.84	8.97	6.82	1.22	5.83	3.75	4.35	3.36	2.77	9.11	57.56
1902	1.98	8.39	5.97	3.00	1.90	3.73	4.44	1.80	4.30	4.73	1.79	5.53	47.56
1903	3.93	6.30	7.23	3.36	0.45	5.73	4.74	4.53	1.64	3.39	1.71	3.07	46.08
1904	4.39	2.78	3.36	8.87	2.87	1.32	3.83	2.75	6.32	2.29	1.63	2.53	42.94
1905	4.45	1.85	2.69	3.78	1.57	4.34	0.66	2.54	7.67	2.22	1.99	4.63	38.39
1906	2.75	3.16	5.08	3.01	6.58	4.30	6.62	2.79	2.57	6.41	2.45	4.56	50.28
1907	3.35	1.93	2.21	3.61	3.72	3.17	1.88	0.75	9.11	4.21	6.98	5.82	46.74
1908	4.14	5.22	4.30	2.33	5.60	1.44	7.08	4.56	0.93	3.52	0.87	2.78	42.77
1909	3.07	6.25	3.73	5.34	1.70	2.60	1.80	2.01	4.31	1.26	3.77	4.55	40.39
1910	4.88	3.38	1.82	1.97	2.16	3.24	1.20	2.02	1.60	1.26	4.94	2.31	30.78
1911	3.04	2.39	3.63	3.51	1.98	2.38	3.75	6.92	2.59	2.99	6.20	3.60	42.98
1912	3.49	2.82	7.87	4.12	4.24	0.65	3.16	3.58	1.85	3.49	3.37	6.09	44.73
1913	3.33	3.03	6.39	5.06	2.30	1.15	2.48	3.64	3.77	6.85	2.66	3.88	44.54
Av.	3.43	3.71	4.86	4.38	3.22	2.72	3.65	3.20	3.92	3.54	3.16	4.50	44.29

RAINFALL AT PAWTUCKET, R. I. Elevation, 140 feet.
(Masonic Building, Board of Public Works.)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1901	1.76	0.94	7.27	6.54	6.24	0.98	3.65	1.60	3.65	2.87	2.11	8.95	46.56
1902	1.98	7.52	6.28	3.23	1.15	4.91	3.95	2.46	3.93	4.81	1.61	5.76	47.59
1903	4.85	6.96	7.82	3.42	0.88	6.62	4.07	4.04	0.91	2.79	1.69	3.38	47.43
1904	7.24	3.86	3.45	8.88	2.24	2.94	1.46	4.41	5.93	2.19	1.75	3.80	48.15
1905	4.59	2.52	2.14	3.53	1.20	4.85	2.40	2.90	7.82	2.31	2.03	6.35	42.64
1906	3.19	3.21	5.49	3.10	5.25	4.31	5.46	4.71	3.70	4.75	2.40	4.82	50.39
1907	4.09	2.75	2.24	4.00	4.40	3.03	2.39	1.01	9.74	3.99	6.01	6.61	50.29
1908	5.01	5.69	4.37	2.52	5.42	3.17	5.52	5.13	1.13	3.82	1.01	4.19	46.98
1909	3.72	6.80	4.13	6.48	1.95	2.21	1.08	2.58	3.81	1.64	3.46	4.27	42.13
1910	5.90	5.29	1.00	1.99	2.63	3.71	2.96	2.36	2.92	2.12	3.86	3.31	38.05
1911	3.19	2.52	3.62	3.21	2.05	1.95	4.19	5.47	2.37	3.14	6.88	3.17	42.06
1912	3.76	3.12	7.85	3.94	4.27	0.63	3.47	3.99	2.05	3.22	3.36	6.83	46.49
1913	3.22	3.12	4.90	5.43	2.10	1.41	3.90	3.05	2.57	6.51	2.34	3.75	42.33
Av.	4.04	4.18	4.66	4.33	3.06	3.13	3.42	3.36	3.89	3.40	2.96	5.04	45.47

RAINFALL AT PAWTUCKET, R. I. Elevation, 40 feet.
(Filter Beds, Board of Public Works.)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1901	2.07	0.94	7.81	7.45	6.60	0.97	3.46	1.72	3.86	2.86	2.48	9.07	49.29
1902	2.23	8.52	6.50	3.04	1.13	4.92	3.29	2.11	4.66	4.51	2.01	6.31	49.23
1903	5.61	7.32	8.37	3.84	0.63	6.96	3.85	3.83	0.75	2.61	1.54	3.36	48.67
1904	9.19	4.29	4.36	8.79	2.41	2.91	1.48	5.10	4.69	2.04	2.02	3.88	51.16
1905	4.91	2.60	2.02	3.51	1.18	4.79	2.29	3.18	6.87	2.10	1.89	6.22	41.56
1906	3.17	2.75	5.07	2.72	4.73	3.91	4.63	3.75	3.07	5.77	1.99	5.16	46.72
1907	4.10	2.98	1.45	2.15	3.85	2.82	1.51	0.88	9.30	3.64	6.00	6.10	44.78
1908	5.05	5.79	4.92	2.60	5.24	2.27	4.53	4.35	1.15	3.65	0.93	4.05	44.53
1909	4.10	6.72	4.05	6.04	1.87	2.13	0.89	2.93	3.48	1.50	3.60	3.92	41.23
1910	4.97	4.74	0.91	1.46	3.16	3.57	3.03	2.54	3.34	2.31	4.24	2.59	36.86
1911	3.27	2.83	3.57	3.46	2.17	2.66	4.06	4.72	2.39	3.06	6.46	3.61	42.26
1912	3.91	3.08	7.21	3.76	4.42	0.76	2.92	4.17	1.68	2.91	3.36	6.92	45.10
1913	3.15	3.53	5.12	5.71	2.19	1.36	3.73	3.54	3.12	6.66	2.44	4.22	44.77
Av.	4.29	4.32	4.72	4.19	3.04	3.08	3.05	3.29	3.72	3.36	3.00	5.03	45.09

RAINFALL AT PROVIDENCE, R. I. Elevation, 162.5 feet (mean high tide).
1832–1876, President Caswell, Brown University, College Hill; 1877–1913, Hope Reservoir, City Engineer.

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1832	3.87	4.25	3.20	3.33	4.14	0.33	1.82	3.92	3.50	2.01	3.46	5.63	39.46
1833	1.71	1.55	1.97	3.17	0.99	4.81	1.11	2.15	1.53	5.98	4.50	4.67	34.14
1834	1.57	1.13	1.43	3.13	5.61	5.10	7.58	1.15	3.81	4.64	3.80	2.97	41.92
1835	3.50	1.20	4.60	4.06	1.50	1.95	2.84	2.25	0.83	3.26	1.72	3.25	30.96
1836	5.63	3.45	5.00	2.30	2.51	3.25	1.53	0.72	1.03	2.35	5.25	4.85	37.87
1837	1.40	2.65	3.17	4.65	7.28	2.82	1.38	2.00	0.48	1.29	1.95	2.55	31.62
1838	2.70	2.32	2.70	2.70	3.88	3.30	0 63	3.55	6 76	4.61	3.65	1.08	37.88
1839	0.76	1.50	1.50	3.63	3.79	2.31	5.26	5.00	1.83	3.75	2.30	5.12	36.75
1840	2.80	2.05	3.50	3.45	3.35	2.89	3.38	3.20	2.95	5.17	5.35	3.10	41.19
1841	6.45	1.50	2.86	7.78	2.18	0.98	5.13	5.12	2.35	3.20	4.45	5.86	47.86
1842	1.30	4.05	2.07	2.10	3.40	9.65	1.48	3.35	1.40	1.16	3.82	3.93	37.71
1843	0.60	5.27	5.58	4.34	3.50	2.12	1.83	6.23	2.20	6.45	1.35	3.03	42.50
1844	4.32	1.95	4.75	0.67	1.95	1.15	4.42	1.11	2.83	5.80	3.30	2.75	35.00
1845	3.20	2.70	3.53	2.34	2.75	2.32	3.10	5.63	1.63	3.40	9.08	3.48	43.16
1846	1.82	2.08	2.86	1.75	4.58	1.30	1.44	2.73	2.33	1.85	4.62	3.15	30.51
1847	2.13	2.71	3.17	1.72	2.02	6.98	2.28	5.50	8.35	1.95	5.72	5.97	48.50
1848	4.82	3.80	2.40	0.95	5.00	3.80	1.85	3.73	2.45	4.05	3.80	3.83	40.48
1849	0.80	0.60	5.99	1.62	3.43	1.23	2.00	3.39	3.14	6.55	2.42	3.52	34.69
1850	5.60	3.38	5.19	4.67	5.00	2.60	2.35	7.65	5.00	2.10	2.10	5.85	51.49
1851	1.93	3.87	2.00	7.80	3.58	1.90	5.19	3.77	2.47	3.20	5.05	2.62	43.38
1852	2.70	2.00	3.55	6.65	2.00	1.00	1.68	8.00	1.40	1.30	4.60	3.70	38.58
1853	4.27	5.75	1.35	5.05	4.95	0.90	6.37	8.38	3.80	4.15	4.40	3.90	53.27
1854	1.80	4.85	2.85	6.30	3.60	3.60	2.45	0.30	6.10	1.90	9 15	3.35	46.25
1855	6.45	4.05	0.85	2.50	2.55	1.95	3.25	2.02	0.25	5.33	3.75	6.10	39.05
1856	5.25	0.80	1.55	2.80	4.10	2.47	4.20	5.75	5.10	1.15	2.00	5.80	40.97
1857	5.50	2.36	3.35	6.29	4.33	1.90	3.45	4.80	2.27	2.90	2.40	5.20	44.75
1858	3.33	2.80	2.05	3.63	2.35	5.55	4.90	8.20	3.05	2.80	2.40	3.45	44.51
1859	5.75	1.85	8.00	2.28	3.40	7.06	1.14	3.69	3.65	2.62	2.27	3.45	45.16
1860	1.00	3.54	1.80	1.55	1.65	4.02	3.09	5.70	5.38	2.10	3.95	4.66	38.44
1861	4 87	2 95	4 62	7 75	3 22	4 61	2.21	4.50	2 75	2.17	3 20	1 40	44.25

RAINFALL AT PROVIDENCE, R. I. — *Continued.*

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1862	6.06	3.15	4.12	1.60	2.60	6.75	3.52	1.47	7.35	4.77	6.85	2.10	50.34
1863	4.61	4.04	4.88	5.52	2.33	1.90	9.42	4.59	1.74	2.97	7.51	5.66	55.17
1864	4.66	1.53	4.74	2.46	3.15	1.22	1.46	4.05	2.36	2.85	3.42	4.95	36.85
1865	5.29	5.45	5.56	2.98	6.23	1.56	3.91	0.74	0.27	4.60	4.03	4.08	44.70
1866	2.35	5.64	4.29	2.02	5.29	4.43	2.03	3.54	5.75	2.78	3.97	3.96	46.05
1867	5.72	6.80	5.32	2.24	3.94	1.56	3.15	8.23	0.62	4.07	2.59	2.80	47.04
1868	4.56	1.71	4.63	7.02	10.57	4.42	2.09	4.55	5.95	1.23	4.39	2.40	53.52
1869	3.92	5.19	6.34	2.07	5.20	5.63	0.88	1.58	5.08	5.92	2.19	4.70	48.70
1870	6.22	3.34	5.47	5.50	2.55	8.22	2.48	1.71	2.11	5.62	2.83	2.97	49.02
1871	2.35	3.80	5.25	3.81	3.80	5.57	3.63	5.73	1.00	6.68	3.35	2.94	47.91
1872	2.45	1.56	5.02	2.35	3.64	3.03	5.31	6.12	6.18	5.34	4.95	2.76	48.71
1873	5.56	4.60	3.67	3.57	4.62	2.74	2.89	7.89	2.17	4.80	5.16	4.99	52.66
1874	3.62	4.40	2.00	8.54	3.04	3.21	2.58	7.71	2.20	0.92	2.66	2.51	43.39
1875	3.54	3.76	4.57	5.02	3.44	7.27	3.56	8.85	2.05	4.07	5.12	0.97	52.22
1876	1.28	4.42	9.75	4.24	3.23	1.40	4.14	1.82	5.73	2.15	6.95	5.25	50.36
1877	4.55	0.33	7.99	2.40	4.40	4.60	3.60	6.41	0.90	5.81	6.41	1.40	48.80
1878	3.53	5.70	3.86	5.42	2.00	4.59	2.31	3.88	1.25	4.57	8.81	6.56	52.48
1879	2.91	4.32	5.59	4.67	1.27	3.10	4.10	5.03	2.42	1.00	2.53	3.65	40.59
1880	2.88	5.53	4.59	3.25	0.83	1.05	6.07	5.19	2.09	3.06	3.14	3.61	41.29
1881	6.17	6.30	5.30	1.56	2.26	6.10	4.09	0.49	2.02	2.46	4.65	3.39	44.79
1882	7.99	4.90	3.50	2.81	3.83	2.32	1.93	1.53	7.83	2.78	2.29	3.25	44.96
1883	5.97	4.50	2.58	2.04	4.33	1.26	3.18	0.83	2.50	5.23	2.59	4.53	39.54
1884	4.96	6.46	4.58	4.35	3.20	3.87	3.07	4.03	1.23	2.74	3.55	6.72	48.76
1885	6.03	4.13	1.50	2.85	3.53	2.07	2.20	4.78	0.80	5.51	3.59	2.71	39.70
1886	7.10	11.31	3.28	2.87	3.86	1.31	1.99	4.22	2.77	3.53	3.86	5.92	52.02
1887	6.61	5.87	4.74	4.40	2.23	4.24	6.09	5.87	1.58	2.99	2.16	4.20	50.98
1888	4.63	4.29	6.65	2.81	5.65	1.07	2.55	7.84	9.19	5.37	9.02	4.37	63.44
1889	5.62	2.55	1.98	4.07	4.71	2.90	9.49	5.83	5.23	4.52	6.39	2.62	55.91
1890	2.79	3.35	8.27	3.59	5.47	2.68	1.81	2.61	4.82	9.19	0.74	5.28	50.60
1891	8.14	6.00	5.55	3.58	2.29	3.50	3.31	6.26	2.77	4.70	2.84	4.25	53.19
1892	5.15	1.72	4.45	1.39	6.07	2.89	1.86	3.07	1.81	1.36	6.12	1.50	37.39
1893	3.47	7.88	5.59	4.51	6.24	3.59	1.10	4.24	2.27	4.25	2.72	5.42	51.28
1894	4.14	4.55	1.33	3.72	5.04	0.56	1.77	2.14	3.09	6.79	3.52	5.62	42.27
1895	5.74	1.90	3.31	6.25	3.88	2.66	4.64	2.71	2.20	8.08	6.66	2.78	50.81
1896	3.52	6.62	6.14	1.22	3.13	3.90	1.34	2.56	8.53	2.71	3.37	2.87	45.91
1897	6.24	3.00	2.95	3.30	4.46	3.31	5.56	4.47	1.77	0.49	7.09	4.99	47.63
1898	6.01	6.45	2.95	6.08	4.07	1.16	10.26	6.00	2.26	8.43	7.29	2.54	63.50
1899	5.18	6.00	8.38	2.12	2.60	3.62	4.69	1.56	9.16	1.68	2.37	1.88	49.24
1900	4.20	8.17	5.67	1.90	6.24	2.19	2.04	3.13	4.05	2.86	4.54	2.79	47.78
1901	1.93	1.00	8.10	8.90	6.85	1.00	2.93	2.56	4.17	2.98	2.24	9.40	52.06
1902	2.06	6.97	5.71	3.09	1.20	4.17	3.41	2.39	6.55	4.57	1.80	6.40	48.32
1903	4.98	5.64	8.17	4.01	0.58	6.64	4.75	3.92	1.00	2.89	1.77	3.56	47.91
1904	6.45	3.38	3.92	9.45	2.37	2.46	1.06	5.12	5.34	2.11	1.95	4.31	47.92
1905	4.66	2.06	2.16	3.24	1.53	6.22	2.72	2.87	6.51	2.16	1.84	5.38	41.35
1906	3.01	3.23	5.42	2.75	4.64	4.36	5.47	3.14	3.53	5.39	2.31	4.85	48.10
1907	3.40	4.22	1.90	4.61	3.92	2.68	0.98	0.90	9.15	3.76	5.95	6.36	47.83
1908	4.41	5.42	3.86	2.02	5.31	2.37	4.07	5.57	1.08	3.61	0.91	3.92	42.55
1909	3.38	6.55	3.42	5.46	2.27	1.85	0.62	2.83	3.60	1.43	3.47	3.25	38.13
1910	5.07	4.38	1.57	1.85	3.19	3.76	2.97	3.14	2.92	1.74	3.52	2.86	36.97
1911	3.02	2.62	3.61	3.09	2.25	1.98	3.74	5.08	2.30	3.16	6.39	3.38	40.62
1912	4.38	2.76	7.15	3.56	4.78	0.95	2.00	2.80	1.81	2.54	3.32	6.79	42.84
1913	3.55	3.00	5.14	5.93	2.17	1.44	3.43	3.02	3.43	6.69	2.55	4.04	44.39
Av.	4.07	3.85	4.19	3.77	3.64	3.19	3.26	4.03	3.35	3.67	3.98	4.01	45.01

RAINFALL AT PROVIDENCE, R. I. Elevation, 100 feet.
(Ladd Observatory.)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1908	4.12	5.55	4.16	2.24	5.24	2.59	4.31	5.55	1.04	4.03	1.22	3.67	43.72
1909	3.49	6.76	3.81	5.85	2.45	1.93	0.69	2.79	3.85	1.79	3.91	3.25	40.57
1910	5.58	4.11	1.47	1.84	3.26	3.87	2.73	2.76	3.18	2.23	4.05	2.52	37.60
1911	3.14	2.40	3.60	3.43	2.14	1.97	3.75	5.21	2.46	3.15	6.60	3.67	41.52
1912	3.92	2.87	7.14	4.08	4.91	0.67	2.16	3.22	1.99	2.80	3.83	6.78	44.37
1913	3.59	3.41	5.83	6.34	2.12	1.43	3.29	2.91	3.01	6.92	3.23	3.75	45.83
Av.	3.97	4.18	4.34	3.96	3.35	2.08	2.82	3.74	2.59	3.49	3.81	3.94	42.27

RAINFALL AT PROVIDENCE, R. I. Elevation, 275 feet.
(Fruit Hill Reservoir, Providence Water Works.)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1909	3.20	5.74	3.15	5.07	2.09	1.82	0.94	2.71	3.03	1.11	3.24	4.08	36.18
1910	4.82	3.83	1.25	1.86	2.14	3.39	2.42	2.52	3.35	2.00	3.89	2.49	33.96
1911	2.83	2.32	3.11	3.00	2.17	2.35	3.74	5.10	2.03	3.14	6.05	3.33	39.17
1912	3.47	2.67	7.13	3.44	4.50	0.44	3.11	4.13	1.79	2.20	3.35	6.42	42.65
1913	3.33	2.98	5.01	5.73	2.15	1.42	4.07	3.28	3.18	5.82	2.47	3.88	43.32
Av.	3.53	3.51	3.33	3.82	2.61	1.88	2.85	3.55	2.28	2.85	3.80	5.05	39.06

RAINFALL AT PROVIDENCE, R. I. Elevation, 25 feet.
(Pettaconsett Pumping Station, Providence Water Works.)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1877	6.09	1.30	10.39	1.24	2.86	6.07	4.85	1.96	0.73	8.27	8.54	1.25	53.55
1878	6.24	4.00	4.61	5.56	2.45	4.76	3.02	5.35	1.65	6.48	8.86	8.22	61.20
1879	3.26	3.39	5.68	5.93	1.49	3.65	4.55	6.93	3.51	1.10	3.27	4.35	47.11
1885	6.69	3.57	1.27	3.17	4.64	1.87	3.38	5.03	0.98	6.11	2.45	2.83	41.99
1886	6.45	10.98	3.69	3.83	3.92	1.26	1.38	4.19	3.34	4.14	4.01	7.25	54.44
1909	3.78	7.29	3.59	5.91	2.44	2.35	0.63	2.97	3.79	1.38	3.64	2.15	39.92
1910	4.39	3.76	1.53	1.88	2.71	3.45	3.07	3.10	2.33	1.66	3.67	2.52	34.07
1911	3.37	1.70	3.30	3.45	1.87	2.71	4.34	4.15	2.31	3.47	6.67	3.71	41.05
1912	4.17	2.48	7.77	3.04	3.85	0.75	1.09	3.31	2.53	2.22	3.47	6.27	40.95
1913	4.27	2.90	4.29	6.54	2.06	1.26	2.04	2.25	4.43	6.75	2.42	4.47	43.68
Av.	4.87	4.14	4.61	4.06	2.83	2.81	2.84	3.92	2.56	4.16	4.70	4.30	45.80

RAINFALL AT PROVIDENCE, R. I. Elevation, 182 feet.
(Sockanosset Reservoir, Providence Water Works.)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1877	5.66	1.05	10.02	2.37	4.01	5.92	3.99	4.08	0.88	8.71	8.00	0.93	55.62
1878	5.58	4.57	4.29	6.12	2.68	5.02	3.24	5.75	1.68	8.09	9.47	8.66	65.15
1879	3.44	4.57	5.58	6.89	1.49	3.72	4.63	6.97	3.33	1.33	3.25	4.90	50.10
1909	4.32	6.91	3.19	5.88	2.23	2.17	0.63	3.04	3.30	1.46	2.79	3.46	39.38
1910	4.69	3.37	1.48	1.85	2.15	3.41	3.21	3.51	1.87	1.59	3.71	2.39	33.23
1911	3.12	2.05	3.04	3.23	1.60	2.49	4.28	4.78	2.16	3.57	6.34	3.52	40.18
1912	3.67	2.80	7.87	4.28	3.93	0.71	0.93	3.03	2.28	2.12	3.02	5.54	40.18
1913	3.81	2.97	4.43	6.56	2.19	1.18	1.90	2.16	3.57	6.58	2.43	4.39	42.17
Av.	4.29	3.54	4.99	4.65	2.53	3.08	2.85	4.16	2.38	4.18	4.88	4.22	45.75

RAINFALL AT PROVIDENCE, R. I. Elevation, 25 feet.
(Sewage Precipitation Works. City Engineer.)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1909	4.04	6.58	2.92	5.58	2.34	1.65	0.48	2.36	4.13	1.23	3.56	3.00	37.87
1910	5.02	4.44	1.28	1.87	3.39	4.63	3.31	2.72	1.82	1.87	3.74	2.49	36.58
1911	2.93	2.56	3.51	3.32	1.63	2.26	4.13	4.47	2.30	2.84	6.37	3.40	39 72
1912	3.62	2.78	7.43	3.97	3.80	0.49	0.90	2.77	1.89	2.65	2.81	6.53	39.64
1913	3.22	3.00	4.49	6.06	2.16	1.23	2.20	2.66	2.50	7.25	2.29	4.02	41.08
Av.	3.77	3.87	3.93	4.16	2.66	2.05	2.20	3.00	2.53	3.17	3.75	3.89	38.98

RAINFALL AT WOONSOCKET, R. I. Elevation, 160 feet.
(Woonsocket Water Works.)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1886	5.79	8.98	3.05	2.84	3.56	1.58	2.78	5.26	2.09	3.37	3.94	3.30	46.54
1887	6.52	5.11	5.26	2.38	2.13	3.60	5.42	5.98	1.41	2.56	2.65	4.90	47.92
1888	4.64	3.57	5.37	2.68	5.78	2.04	2.51	5.73	9.14	4.34	6.82	5.64	58.26
1889	5.61	1.45	1.70	4.97	3.73	3.07	11.41	4.36	4.67	5.21	6.29	2.98	55.45
1890	3.20	3.68	8.89	4.57	5.68	2.78	3.18	3.32	7.21	9.93	1.04	6.20	59.68
1891	9.02	6.47	6.82	4.97	2.55	4.09	4.35	4.88	3.76	4.34	3.14	4.05	58.44
1892	5.47	1.97	2.98	1.15	6.48	3.03	3.10	5.01	2.61	1.45	6.53	1.50	41.28
1893	3.58	7.65	6.37	5.23	9.19	2.82	1.28	5.41	2.31	6.02	3.37	4.27	57.50
1894	3.62	4.82	1.36	4.55	5.25	0.77	1.85	1.99	2.07	6.46	3.77	4.97	41.48
1895	4.78	1.15	3.27	5.17	2.78	1.99	4.53	2.71	3.65	7.15	8.58	3.01	48.77
1896	2.44	5.00	4.11	1.04	2.24	3.07	1.91	2.72	8.48	3.24	2.42	2.10	38.80
1897	4.24	2.88	2.99	3.22	4.23	3.77	7.05	4.56	2.42	0.69	6.59	5.09	47.73
1898	4.03	6.11	2.74	5.56	3.98	1.31	11.95	6.61	3.29	7.60	6.26	2.37	61.81
1899	5.16	3.72	6.61	2.23	1.27	3.57	5.06	1.96	6.27	1.73	2.97	2.26	42.81
1900	4.62	8.78	6.35	2.12	6.34	5.03	3.06	2.89	3.68	3.60	5.26	2.81	54.54
1901	2.30	1.33	8.32	9.51	6.92	1.11	4.43	3.32	3.98	3.09	2.80	8.71	55.82
1902	2.35	6.22	4.97	2. 0	1.95	3.87	4.35	2.01	3.74	4.28	1.46	6.19	44.19
1903	4.63	4.82	6.95	3.46	0.50	6.17	3.42	4.79	2.29	4.14	1.72	3.37	46.26
1904	5.09	2.87	3.43	9.34	1.87	2.03	2.91	3.46	6.48	2.12	2.17	3.72	45.49
1905	4.56	1.80	2.71	2.80	1.89	3.96	1.30	2.45	6.58	2.27	2.43	4.61	37.36
1906	2.99	2.40	6.06	3.36	7.06	3.59	7.01	3.68	2.62	5.93	2.83	2.38	49.91
1907	5.29	2.50	2.65	4.10	3.80	2.89	2.01	0.87	8.61	4.30	7.14	5.55	49 71
1908	4.65	5.02	3.95	2.03	5.23	2.40	7.58	5.01	1.16	3.24	1.17	4.52	45.96
1909	3.44	4.53	4.40	4.18	4.06	2.91	1.51	3.38	3.95	1.55	3.37	3.86	41.14
1910	5.88	3.92	2.04	2.14	2.11	3.75	1.21	2.70	1.50	1.26	4.72	3.31	34.54
1911	3.20	2.67	3.68	3.43	2 19	2.28	3.85	7.79	2.24	3.41	6.04	3 40	44.18
1912	3.60	2.68	6.92	4.13	4 68	0.76	2.82	3.94	2.14	2.61	3.99	6.47	44 74
1913	3.77	3.23	6.48	5.75	2.87	1.03	2.39	3.81	3.39	6.47	2.92	3.06	45.17
Av.	4.45	4.12	4.66	3.92	3.94	2.83	4.08	3.95	3.99	4.01	4.01	4.09	48.05

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RAINFALL AT BRIDGEPORT, CONN. Elevation, 20 feet.

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1894	2.92	4.57	1.39	2.40	6.12	1.38	0.69	2.29	5.86	7.25	5.85	4.69	45.41
1895	5.65	1.10	3.04	3.32	1.33	4.37	4.86	7.36	1.69	4.41	4.12	2.45	43.70
1896	1.82	6.32	6.96	0.69	4.81	3.88	3.45	2.19	5.40	2.45	3.02	2.00	42.99
1897	3.93	3.00	4.43	2.53	6.62	3.41	18.77	4.11	1.97	2.11	6.40	6.16	63.44
1898	5.89	4.94	3.20	4.72	10.18	0.48	6.25	6.16	2.32	8.96	7.60	3.03	63.73
1899	4.45	4.86	9.64	2.03	2.03	3.50	4.73	0.20	1.55	2.29	1.99	2.26	42.53
1900	4.37	5.99	3.63	2.41	2.90	2.10	2.77	2.60	1.99	2.97	5.25	2.70	39.68
1901	2.12	0.85	6.92	9.41	8.20	0.76	6.41	8.66	5.71	3.37	1.97	9.85	64.23
1902	2.68	5.58	6.55	3.85	1.59	5.70	3.28	2.39	5.58	7.67	1.45	7.64	53.96
1903	4.28	5.38	6.07	3.52	0.49	8.48	2.79	11.24	2.60	5.09	1.83	4.07	55.84
1904	3.95	2.90	3.54	5.83	2.50	2.99	2.51	7.72	5.16	2.32	2.26	3.26	44.94
1905	4.68	2.22	3.29	3.40	0.91	4.30	13.04	4.66	6.16	2.48	2.62	5.00	52.76
1906	3.61	3.08	5.53	5.87	4.14	4.21	3.61	1.55	3.97	7.12	2.81	4.35	49.85
1907	3.91	3.06	2.51	3.22	3.70	3.02	1.90	1.36	8.04	5.03	6.05	5.49	47.29
1908	3.72	6.23	3.39	2.22	6.25	0.71	5.13	9.32	1.01	1.54	1.00	3.73	44.25
1909	3.89	6.10	3.94	7.74	1.78	1.70	2.50	3.59	3.49	1.30	1.94	4.43	42.40
1910	7.59	3.83	1.86	3.62	1.73	4.69	1.36	2.32	1.99	1.25	3.93	2.29	36.46
1911	3.21	3.26	3.66	3.97	1.12	2.58	2.06	6.01	2.69	7.01	5.74	3.49	44.80
1912	2.37	2.32	7.96	4.14	5.37	1.44	2.00	3.41	3.70	1.75	3.30	5.39	43.15
1913	3.66	3.59	5.58	5.36	2.65	1.53	2.05	4.20	3.12	10.18	2.61	4.03	48.56
Av.	3.93	3.96	4.65	4.01	3.72	3.06	4.51	4.57	3.85	4.33	3.59	4.32	48.50

RAINFALL AT CANAAN, CONN. Elevation, 600 feet.
(Falls Village.)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1891	7.44	3.71	2.17	3.75	1.73	3.62	1.62	3.37	0.94	1.60	3.11	4.88	37.94
1892	5.71	1.36	2.76	0.70	6.43	5.74	6.09	6.13	3.45	1.22	3.76	1.24	44.59
1893	2.71	6.23	3.05	2.65	5.52	2.49	3.33	5.50	3.89	3.99	1.84	4.16	45.36
1894	2.03	2.17	1.63	2.55	5.57	0.86	1.35	0.57	4.44	4.06	4.15	4.58	33.96
1895	3.08	1.36	2.44	4.15	2.49	2.77	3.00	2.77	2.24	5.38	3.80	4.67	38.15
1896	1.11	6.38	5.59	1.71	3.39	2.53	6.67	4 25	6.25	3.10	2.80	2.33	46.11
1897	3.25	2.40	2.44	3.00	3.73	5.22	10.57	4.77	5.94	0.78	5.94	4.63	52.67
1898	4.58	3.06	2.44	4.35	6.35	2.99	2.23	8.22	3 73	3.74	6.30	2.42	50.41
1899	3.20	4.69	5.25	1.23	2.68	3.99	7.09	0.88	4.82	1.63	1.47	2.35	39.28
1900	2.72	6.00	4.50	1.69	5.58	4.45	5.02	1.87	1.85	2.41	5.55	2.71	44.35
1901	1.48	0.84	6.09	6.45	6.07	1.84	4.39	9.04	4.21	3.97	2.42	8.16	54.96
1902	2.12	4.38	4.59	3.79	2.65	4.83	7.42	3.24	8.44	4.96	1.01	6.48	53.91
1903	...	4.39	4.48	2.85	0.97	10.01	2.64	5.93	2.02	6.04	2.42	...	...
Av.	3.29	3.55	3.58	3.00	4.35	3.44	4.90	4.22	4.18	3.07	3.51	4.05	45.14

RAINFALL AT CANTON, CONN. Elevation, 900 feet.

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1859	2.10	0.49	5.70	2.85	5.29	7.03	2.07	4.30	5.71	1.68	2.20	2 87	42.29
1860	0.00	1.37	1.41	1.27	2.95	1.25	4.21	5.15	5.23	2.26	7.48	2.27	34.85
1861	1.78	1 84	2.68	5.16	4.39	2.08	4.11	5.65	3.15	5.17	6.01	0.87	42.89
1862	0.87	1.37	4.04	1.63	1.55	11.36	5.88	4.36	3.39	3.94	4.08	1.03	43.50
1863	5.71	5.18	3 24	4.96	3.22	2.52	12.72	3.24	3.34	6,89	6.36	5.43	62.81
1864	1.60	0.99	4.38	3 24	2.55	1.90	1.70	7.28	2.12	5.14	5.99	3.99	40.88
1865	3 23	2 43	6 62	4 16	9 29	4.38	7.45	2 68	1.39	5.69	3 97	3.12	54.41

RAINFALL AT CANTON, CONN. — *Continued.*

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1866	0.81	7.50	2.83	1.27	8.10	9.59	3.21	3.40	8.22	9.94	9.28	7.10	71.25
1867	1.75	4.75	2.94	2.72	6.13	6.18	5.36	16.95	5.49	9.25	5.10	2.09	68.71
1868	3.63	1.50	3.85	4.91	18.00	5.70	2.69	8.62	11.25	1.68	8.68	3.33	73.84
1869	3.15	4.93	6.70	2.49	9.33	11.77	3.64	0.83	6.51	14.70	4.65	6.46	75.16
1870	7.10	8.18	5.51	5.50	1.86	5.39	2.06	1.30	1.52	4.94	3.17	2.37	48.90
1871	2.58	3.10	5.55	3.24	4.71	5.97	3.07	5.46	1.32	5.66	5.69	2.51	48.86
1872	1.90	2.06	3.51	2.32	3.43	4.52	3.84	7.07	5.03	3.11	4.93	2.74	44.46
1873	5.40	2.02	3.30	3.48	5.10	0.20	4.70	6.34	3.52	6.50	3.93	5.52	50.01
1874	5.64	3.35	1.49	7.21	3.70	6.75	7.78	4.34	3.17	1.39	3.50	1.37	49.69
1875	2.28	3.85	3.52	2.87	1.83	2.73	2.31	12.90	1.56	4.12	5.17	0.64	43.78
1876	1.97	5.38	9.57	3.48	5.30	2.21	5.15	1.38	5.12	0.62	3.58	4.01	47.77
1877	2.12	1.32	7.45	2.56	0.99	4.74	3.17	2.93	0.50	9.21	6.50	1.20	42.69
1878	5.42	4.70	3.08	5.44	2.71	5.89	2.76	2.54	4.22	3.54	4.70	7.15	52.15
1879	1.75	2.80	4.86	4.27	2.36	6.15	4.37	5.35	2.58	0.62	2.27	5.08	42.46
1880	3.72	3.40	3.10	4.40	1.19	2.76	5.44	5.54	2.96	4.59	2.98	1.87	41.95
1881	4.59	3.85	5.23	1.52	4.46	4.67	4.72	3.45	0.40	3.56	5.17	5.26	46.88
1882	4.40	3.83	3.37	1.89	4.45	1.87	3.42	1.08	10.13	2.16	1.08	1.55	39.23
1883	3.14	4.65	1.30	2.11	4.15	3.73	3.61	2.33	2.89	6.39	1.98	3.10	39.38
1884	5.94	5.58	4.37	2.89	2.70	2.24	5.40	5.37	0.88	2.89	3.68	6.48	48.42
1885	5.37	3.80	1.04	3.33	3.02	2.30	2.86	9.50	1.50	5.57	5.71	3.86	47.86
1886	5.17	4.78	4.50	3.23	3.36	2.72	4.52	2.77	2.81	2.70	5.37	2.71	44.64
1887	5.87	5.37	3.76	3.39	0.51	6.29	7.40	5.85	2.39	2.90	2.36	4.97	51.06
1888	4.16	5.01	4.64	2.89	4.43	1.49	3.14	3.72	9.92	5.95	4.74	5.45	55.54
1889	5.15	1.57	1.76	4.02	4.11	3.71	9.07	3.71	6.80	4.29	7.62	2.89	54.70
1890	2.47	4.39	5.80	2.35	5.01	3.42	4.66	5.36	5.54	7.88	0.70	4.20	51.78
1891	9.29	4.46	5.10	3.91	2.03	3.11	5.21	4.86	1.46	2.65	3.81	5.04	50.93
1892	5.06	1.54	2.73	0.68	6.80	3.48	4.97	8.13	2.53	1.10	6.49	1.48	44.99
1893	3.47	6.01	4.69	4.22	7.52	5.00	1.95	4.91	3.23	5.92	2.71	4.46	54.09
1894	2.90	3.58	1.71	2.54	5.58	0.58	1.92	0.73	5.58	6.46	3.55	3.77	38.90
1895	3.73	0.66	2.39	3.50	1.79	3.53	3.94	6.02	3.13	6.15	3.96	4.10	42.90
1896	1.93	9.30	5.55	1.03	2.93	3.80	3.39	4.12	6.58	3.73	3.15	1.61	47.12
1897	3.44	3.66	3.41	2.55	4.96	4.92	16.96	6.56	2.09	1.14	6.31	5.71	61.71
1898	4.97	4.12	2.25	3.72	6.74	2.71	4.97	7.02	2.31	5.44	7.22	3.78	55.25
1899	3.17	4.17	6.91	2.03	2.09	6.44	6.83	3.00	4.83	2.50	1.84	2.84	46.65
1900	3.32	9.11	5.66	1.64	6.05	3.81	4.11	2.55	2.56	4.15	6.33	2.60	52.09
1901	1.54	0.49	5.96	12.30	7.21	1.24	3.03	6.42	5.76	4.66	2.27	9.07	59.95
1902	3.11	5.98	5.38	5.13	1.44	4.20	8.71	3.73	7.15	6.11	1.06	6.95	58.95
1903	4.10	4.46	5.31	3.07	0.81	11.69	3.86	7.34	4.46	4.10	3.21	4.60	57.01
1904	4.32	2.17	4.40	5.08	2.43	3.09	3.55	6.24	6.92	3.38	1.30	2.96	45.84
1905	6.69	1.12	3.21	2.38	0.93	3.77	4.22	4.10	5.41	2.68	2.33	3.38	40.22
1906	2.14	1.97	4.95	4.97	4.43	2.48	7.80	3.19	3.01	5.63	2.36	4.09	47.02
1907	3.22	2.18	1.34	2.30	3.91	4.18	1.45	1.37	10.50	6.91	5.93	5.36	48.65
1908	4.08	6.04	3.11	3.17	5.69	2.16	3.87	3.03	1.62	2.34	0.82	3.20	39.13
1909	3.62	6.39	4.83	8.25	2.87	1.96	3.28	4.14	3.96	1.62	2.18	5.14	48.24
1910	7.89	5.11	0.69	3.96	3.64	4.37	3.00	3.68	4.24	1.02	6.42	2.08	46.10
1911	2.62	2.44	4.89	3.28	2.60	2.57	2.90	5.38	4.98	9.58	4.08	2.97	48.29
1912	2.13	3.20	6.87	4.27	4.48	0.90	2.65	3.38	2.72	4.15	4.66	4.26	43.67
1913	3.42	2.47	5.34	4.90	4.47	0.72	1.36	4.27	4.23	9.97	3.72	2.92	47.79
Av.	3.66	3.74	4.14	3.56	4.21	4.08	4.55	4.81	4.18	4.66	4.26	3.74	49.59

RAINFALL AT COLCHESTER, CONN. Elevation, 370 feet.

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1891	...	...	...	...	...	...	...	...	...	4.96	3.64	5.13	...
1892	4.76	1.22	3.50	1.21	5.05	1.17	3.33	3.91	1.34	1.28	7.58	1.37	35.72
1893	3.18	4.85	5.48	5.41	7.97	1.90	1.43	4.23	3.06	6.60	3.40	3.09	50.60
1894	2.45	3.20	1.55	4.59	4.03	0.49	2.05	1.07	3.01	5.83	4.51	4.08	36.86
1895	4.79	0.51	2.13	6.86	1.89	2.02	4.11	3.63	1.57	6.77	6.50	3.58	44.36
1896	1.84	8.34	5.20	1.80	4.97	3.00	2.45	4.05	6.60	4.65	3.42	3.07	49.39
1897	5.85	2.65	3.26	2.77	5.01	2.64	10.82	8.67	2.85	1.37	6.18	5.55	57.62
1898	4.83	4.80	2.86	5.41	6.16	0.79	5.05	8.65	2.61	6.39	6.32	2.63	56.50
1899	4.61	4.62	6.45	2.74	2.11	2.82	5.38	4.21	3 47	1.21	2.44	2.32	42.38
1900	4.26	9.68	6.26	1.94	3.93	1.80	2.43	0.86	2.48	3.92	6.78	2.17	46.51
1901	1.83	0.55	6.97	9.63	7.29	2.33	6.64	7.83	5.47	2.82	2.71	10.05	64.12
1902	2.99	5.10	6.09	3.58	1.55	3.65	4.75	2.10	6.98	5.78	1.36	8.06	51.99
1903	3.83	6.12	7.93	3.12	0.42	8.40	3.72	6.00	2.97	4.12	1.89	4.82	53.34
1904	4.90	3.67	3.50	8.52	2.74	2.87	2.44	5.07	6.40	2.71	2.74	3.66	49 22
1905	3.89	2.00	3.31	3.89	1.82	5.52	2.26	4.10	4.98	2.54	2.71	5.50	42.52
1906	4.14	2.47	5.08	4.53	5.33	4.64	4.71	1.54	2.95	6.56	2.65	3.58	48 18
1907	4.28	3.58	1.83	3.55	3.61	2.67	1.70	1.33	5.20	5.44	7.31	6.01	46.51
1908	4 75	6.84	3.39	3.07	6.31	1.98	5.32	6.30	1.64	2.20	0.95	3.85	46 60
1909	3.18	8.71	4.27	6.53	2.66	2.80	1.23	3.15	5.89	1.92	2.07	4.38	46.79
1910	6.97	3.39	3.64	4 09	2.39	4.01	2.63	1.94	2.63	1.66	4.72	2.65	40.72
1911	4.45	3.04	4 43	3.78	0.84	2.13	3 01	7.23	2.78	5.82	6.97	3.35	47.83
1912	1.98	2.94	8 27	5.11	5.82	0.67	2 82	5.59	3.18	2.29	4.28	6.27	49.22
1913	3.63	2.93	6.18	6.68	2.86	1.70	1.70	2.91	3.54	9.23	2.80	4.33	48 49
Av.	3.97	4.15	4.62	4.49	3.85	2.73	3.64	4.29	3.71	4.14	4.10	4.29	47.98

RAINFALL AT CORNWALL, CONN. Elevation, 1 300 feet.

(Cream Hill.)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1896	...	...	...	...	...	2.65	4.69	4.68	5.36	3.20	2.98	1.78	...
1897	3.54	2.21	2.09	3.16	4.22	5.15	9.71	5.28	2.85	1.04	5.54	4.53	49 32
1898	3.52	3.68	2.37	4.31	6.70	2.87	1.79	6.77	4.25	3.35	6.46	2.17	48.24
1899	3.47	4.13	5.84	1.47	1.75	3.39	6.70	1.11	4.21	1.67	1.59	2.21	37.54
1900	2.82	5.97	3.84	1.95	5.13	4.42	6.09	2.18	1.75	2.73	5.29	3.00	45.17
1901	1.52	0.84	7.33	6.83	6.90	1.69	4.57	6.97	4.52	4.37	3.26	8.14	56.94
1902	3.26	4.90	4.68	4.76	2.99	5.06	9.40	4.70	7.83	5.42	0.75	7.68	61.43
1903	3.93	4.97	4.94	3.20	1.39	9.74	4.07	5.65	2.85	6.39	3.10	6.65	56.88
1904	4.69	3.13	4.46	3.12	4.28	3.52	6.15	3.89	7.92	2.71	1.24	3.09	48.20
1905	6.91	1.68	3.12	2.74	2.35	3.90	5.83	4.71	6.83	2.90	2.19	2.59	45.75
1906	2.41	2.55	4.06	3.67	5.61	5.60	6.47	3.14	3.58	4.02	1.36	3.84	46.31
1907	2.75	3.12	1.34	3.58	4.42	4.23	2.10	2.11	12.22	9.69	4.69	5.55	55.80
1908	3.95	5.23	2.84	2.10	4.20	2.45	6.65	5.29	1.30	1.99	0.92	3.34	40.26
1909	5.14	6.57	5.16	4.02	3.96	2.94	2.37	4.53	4.21	0.87	2.41	2.57	44 75
1910	6.62	5.20	0.90	3.72	3.93	3.89	2.17	5.24	4.05	1.38	5.39	3.16	45.65
1911	3.01	1.71	3.79	2.12	3.03	2.88	5.35	7.27	3.86	5.47	4.02	1.90	14.41
1912	2.89	1.15	4.80	4.28	6.89	1.28	2.96	4.26	3.42	4.85	4.06	4.03	44.87
1913	2.98	2.14	4.80	3.17	4.92	1.67	1.37	3 89	3.81	9.08	3.23	2.03	43.09
Av.	3.73	3.48	3.90	3.42	4.28	3 81	4.93	4.53	4.67	4 00	3.26	3.91	47.92

RAINFALL AT DANIELSON, CONN. Elevation, 300 feet.

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1905	3.50	1.11	2.24	2.17	1.41	3.42	1.18	2.76	4.33	2.23	2.21	3.62	30.18
1906	4.04	3.66	4.86	2.57	4.69	6.10	1.89	2.00	1.98	2.77	4.10	5.70	44.36
1907	5.62	2.83	1.75	1.90	1.91	3.10	2.55	2.20	11.23	6.97	5.69	4.90	50.65
1908	2.70	4.50	1.50	1.62	3.68	2.82	3.51	5.70	1.32	2.00	1.06	3.59	34.00
1909	3.99	6.35	3.83	5.28	3.63	1.62	1.32	1.69	6.11	1.36	2.08	3.80	41.06
1910	6.14	3.07	1.78	2.55	2.11	2.84	2.76	1.37	4.02	1.88	3.19	4.78	36.49
1911	3.51	3.20	4.54	4.55	1.51	1.32	3.73	8.20	3.60	3.03	7.23	3.30	47.75
1912	3.58	2.80	8.17	4.11	4.82	0.34	1.95	3.81	3.80	1.67	4.43	6.78	46.26
1913	3.67	3.86	6.35	5.60	2.78	2 02	3.18	3.32	3.27	5.82	3.75	3.30	46.92
Av.	4.08	3.49	3.89	3.37	2.95	2.62	2.45	3.45	4.41	3.08	3.75	4.42	41.96

RAINFALL AT HARTFORD, CONN. Elevation, 159 feet.

(Hartford Water Works.)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1868	3.23	1.75	2.75	4.95	9.10	4.56	1.83	7.15	9.98	0.77	4.45	1.48	52.00
1869	3.60	3.94	6.39	1.63	4.86	7.76	1.33	1.07	3.46	13.33	3.40	5.04	55.81
1870	4.84	6.15	5.26	4.24	1.15	4.18	1.36	1.64	0.70	4.86	3.40	1.95	39.73
1871	2.26	3.20	5.09	2.07	4.78	6.16	2.91	7.02	1.24	6.49	3.60	1.99	46.81
1872	1.08	1.94	3.29	1.35	3.41	4.26	6.08	6.50	3.95	2.60	4.27	2.80	41.53
1873	4.07	2.35	2.20	3.45	6.25	0.15	1.98	6.02	2.56	3.62	2.43	3.87	38.95
1874	5.57	2.75	1.15	6.49	3.52	4.86	5.22	6.50	2.83	1.12	2.30	1.35	43.66
1875	2.06	3.40	3.31	3.15	1.18	2.59	2.18	7.86	1.40	3.60	4.37	0.92	36.02
1876	1.25	4.29	8.47	2.97	4.45	2.54	5.94	0.25	4.43	1.00	3.56	4.45	43.60
1877	2.83	1.09	9.38	2.18	0.43	5.29	3.09	3.63	0.37	7.21	6.09	0.67	42.26
1878	5.78	3.95	3.00	4.59	2.32	4.11	2.22	3.75	2.22	2.22	5.25	5.94	45.35
1879	1.71	3.05	3.03	4.00	1.60	3.74	3.36	6.50	1.70	0.73	1.61	3.08	34.11
1880	2.78	3.06	3.00	1.83	0.73	2.03	7.02	5.20	2.98	1.60	4.80	1.85	36.88
1881	3.80	2.30	4.70	1.16	3.83	2.35	4.80	3.00	0.25	1.86	4.80	4.06	36.91
1882	2.42	5.77	2.60	1.15	3.42	1.31	3.22	1.15	10.88	2.69	0.85	1.58	37.04
1883	1.95	4.42	1.65	1.24	2.95	2.30	3.17	3.20	3.13	5.89	1.30	2 44	33.64
1884	4.45	5.62	4.87	3.29	2.43	1.53	3.83	3.11	0.89	2.48	2.85	6.21	41.56
1885	4.80	3.35	1.00	3.14	2.60	2.73	6.35	10.27	2.18	5.16	4.63	2.50	48.71
1886	5.28	6.08	2.58	3.83	3.18	1.97	5.45	2.43	4.31	2.29	4.67	3.76	45.83
1887	5.84	6.37	4.46	2.52	0.20	6.00	4.52	7.65	2.12	2.99	2.78	4.80	50.25
1888	4.22	4.07	3.03	2.10	4.50	1.12	2.98	3.84	8.55	5.23	5.22	5.43	50.29
1889	4.97	1.34	1.64	3.47	3.00	3.69	9.33	4.70	3.72	5.10	8.29	2.41	51.66
1890	2.25	3.48	6.18	2.92	5.08	3.37	3.83	4.12	4.55	5.86	0.80	3.18	45.62
1891	8.48	4.27	4.75	3.35	2.00	1.92	5.41	3.52	3.28	3.57	2.93	4.99	48.47
1892	4.77	1.68	2.16	1.01	5.59	2 31	2.84	6.69	2.57	1.39	5.81	1.43	38.25
1893	3.20	4.27	5.11	3.61	7.18	2.71	2.18	4.37	2.08	5.35	2.59	3.67	46.32
1894	1.72	3.12	1.88	2.23	6.14	0.48	1.36	2.25	5.80	5.94	5.13	4.12	40.17
1895	4.83	1 42	2.90	4.38	2.13	2.20	4.54	6.92	2.34	4.52	6.01	3.18	45.37
1896	1.32	7.10	4.86	0.73	2.17	4.83	2.78	3.82	5.96	3.42	2.74	1.02	40.75
1897	3.50	3.14	2.98	2.21	5.43	4.24	15.14	3.57	1.65	0.60	5.85	5.28	53.59
1898	3.31	4.26	2.01	3.19	5.63	1.80	4.17	7.20	2.14	5.51	7.91	2.09	49.22
1899	3.35	2.53	5.92	2.74	2.16	2.52	4.83	0.90	3.53	2.20	2.68	1.42	34.78
1900	3.60	8.28	6.29	1.53	4.26	3.66	3.93	3.13	1.98	3.03	4.81	2.79	47.29
1901	1.39	0.50	6.83	11.17	7.23	0.69	3.24	5.53	4.64	3.74	2.06	9.34	56.36
1902	2.22	3.02	6.02	3 95	2 04	3 94	7 03	4 70	6 08	6.30	0 74	6.65	52.69

RAINFALL AT HARTFORD, CONN. — *Continued.*

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1903	3.14	4.50	6.42	2.90	0.25	10.81	5.63	7.53	4.48	3.70	2.42	3.34	55.12
1904	3.24	2.31	3.20	5.70	2.86	2.45	3.51	5.49	6.93	2.78	1.32	2.28	42.07
1905	3.46	1.33	3.36	2.43	1.21	4.63	3.62	6.40	4.40	2.57	2.10	3.94	39.45
1906	2.25	1.67	4.53	4 76	4.21	2.11	6.32	2.05	3.20	6.28	2.52	2.17	42.07
1907	4.53	1.92	1.07	2.66	3.77	4.10	1.73	1.30	10.77	6.33	5.63	5.45	49.26
1908	3.47	5.33	3.09	1.97	7.11	1.76	5.05	5.41	1.63	1.62	1.00	3.65	41.09
1909	3.23	5.24	4 20	7.59	2.56	3.15	1.63	3 90	3.72	1.85	2 15	3.20	42.42
1910	6.28	3.62	1.16	1.12	2.77	4.07	2.55	2.49	3.34	0.81	4.78	1.69	37.68
1911	2.80	2.39	3.94	3.03	1.79	2.52	2.68	6.38	2.39	10.02	4.41	3.19	45.54
1912	1.50	3.21	6.76	3.99	5.17	0.57	2.26	3.15	2.09	1.78	4.09	4.59	39.16
1913	2.84	2.06	5.58	4.72	5 13	1.24	1.72	3.91	3.90	9.67	2.70	3.66	47.13
Av.	3.46	3.50	4.00	3.30	3.56	3.20	4.05	4.50	3 64	3.95	3.65	3.37	44.18

RAINFALL AT MANSFIELD, CONN. Elevation, 640 feet.

(Storrs.)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1893	2.39	5.88	4.67	3.82	7.12	1.98	1.58	3.79	2.58	6.71	2.45	3.68	46.65
1894	2.24	3.13	1.18	2.67	3.58	0.59	2 09	2.37	3.01	4.16	4.00	4.31	33.33
1895	5.78	0.63	2.62	4.27	2.16	1.78	4.13	3.48	2.97	6 74	6.97	4.12	45.65
1896	1.60	7.10	4.86	0.80	2.72	1.78	3.22	2.71	7.03	3.60	2.49	2.67	40.58
1897	3.84	3.40	3.66	2.37	4.44	2.79	12.24	5.23	1.39	0.92	7.14	5.61	53.03
1898	4.70	4.03	3.09	4.44	3.81	2.48	6.24	5.87	2.22	6.18	6.11	1.96	51.13
1899	3.76	3.97	6.30	2 20	1.27	3.72	5.55	3 27	3.31	1.54	2 10	2.14	39.13
1900	3.42	7.31	6.73	2.67	4.91	4.32	2.76	2 03	2.27	3.00	6.79	2.22	48.43
1901	2.17	1.05	7.18	9.51	6.30	1.96	5.54	7.58	4.33	1.97	3 04	9.55	60.18
1902	2.53	5.11	6.35	3.88	1.59	3.24	7.48	2.17	7.05	5.68	1.10	5.86	52.04
1903	3.79	5.18	7.09	2.81	0.50	9.24	4.56	4.52	1.81	2.79	1.95	4.27	48.51
1904	4.55	2.80	3.31	6.40	1.96	2.53	1.85	6 00	4.71	2.19	1.47	2.42	40.19
1905	3 57	1.21	3.45	2.87	0.90	4.53	1.77	2.63	5.79	2.57	2.73	4.12	36.14
1906	3.16	2.68	5.46	4.40	5.87	2.18	5.03	2 16	2.65	4.85	2.39	2.80	43.63
1907	3.13	0 37	1.68	2.40	3.16	2.81	1.45	1.09	9.71	4.97	6.91	5.28	42.96
1908	3.26	5.20	3.94	1.56	6.54	2.42	5.37	5.91	1.45	1 84	0.80	3.69	41.98
1909	2.77	6.95	3.99	4.38	3.89	2.02	0.84	2.01	5.32	1.59	1.73	3.82	39.31
1910	5.73	3.93	1.31	3.20	1.50	4 88	2.24	1.99	4.66	1.42	3.51	2.39	36.76
1911	1.05	2.73	3.56	2.61	0.33	1.20	2.30	5.08	2.94	6.24	4.39	3.53	35.96
1912	1.43	2.10	7.29	3.09	4.38	0.29	3 62	5.49	2.33	1.97	3.81	5.73	41.53
1913	3.95	2.80	5.03	4.80	2.65	2.32	4 25	3.55	2.60	5.70	2.05	3.18	42.88
Av.	3.28	3.69	4.42	3.58	3.31	2.81	4.00	3.76	3.82	3.65	3.52	3.97	43.81

RAINFALL AT MIDDLETOWN, CONN. Elevation, 125 feet.

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1858	. .	...	...	...	...	...	...	...	4.94	2.83	3.06	3.48	....
1859	7.18	4.20	7.52	3.06	4.18	6.09	2.17	6.57	3 90	2.13	2.45	3.88	53.33
1860	1.69	2.62	1.68	1.71	3.86	3.14	2.76	3.70	3.70	2.56	4.74	5.23	37.39
1861	4.13	2.68	4.22	4.97	6.82	3.65	3.54	6.09	3.88	2.20	3.28	1.57	47.03
1862	5.21	2.14	3.87	1.59	2.37	8.05	6.24	1 65	5.45	2.94	5.79	1.73	48 03
1863	4.24	5.11	4.73	4.26	1.74	1.01	11.14	4 90	1.73	3.34	5.02	5.25	52.47

RAINFALL AT MIDDLETOWN, CONN.—*Continued.*

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1864	3.07	1.40	2.06	1.82	3.82	3.00	1.68	2.92	3.45	2.66	4.13	3.99	34.00
1865	4.16	3.61	4.75	3.41	6.85	2.41	4.65	1.85	0.75	3.21	3.96	2.99	42.60
1866	1.61	5.11	2.60	2.90	5.38	3.02	4.04	4.24	6.74	2.98	4.34	3.31	46.27
1867	2.41	4.34	3.51	2.44	4.53	5.39	3.31	10.22	2.83	4.12	2.75	2.49	48.34
1868	3.36	1.53	2.78	4.48	7.63	5.24	2.36	7.39	10.49	0.89	4.00	2.39	52.54
1869	3.17	5.04	7.51	1.95	6.05	5.38	2.96	2.80	3.90	15.54	3.34	6.33	63.97
1870	5.72	5.45	5.97	5.32	1.74	2.73	1.42	3.29	1.33	4.23	3.08	2.30	42.58
1871	3.43	4.10	6.52	3.14	4.80	4.24	5.48	8.02	1.94	3.69	4.51	3.31	53.18
1872	2.19	2.87	4.02	1.95	3.09	4.89	5.43	5.58	4.94	2.47	5.08	4.08	46.59
1873	6.79	3.03	2.95	3.16	4.25	0.46	2.09	8.31	2.37	6.18	4.29	5.06	48.94
1874	5.98	3.69	1.45	7.11	3.48	2.21	5.78	6.30	2.82	1.44	2.64	2.31	45.21
1875	2.86	4.86	5.18	3.89	1.44	3.25	2.49	5.64	1.59	4.56	5.73	1.20	42.69
1876	1.45	5.11	9.49	3.71	2.87	1.89	10.20	1.23	6.04	1.16	4.05	4.21	51.41
1877	3.38	1.14	9.24	2.60	1.11	6.58	2.99	6.15	0.94	9.11	7.29	1.56	52.09
1878	5.77	5.13	2.89	4.42	2.93	3.68	1.99	4.89	1.80	2.74	5.48	7.91	49.63
1879	2.49	4.07	5.53	5.95	2.69	4.38	5.88	8.24	1.88	1.18	1.78	3.84	47.91
1880	3.50	3.68	3.51	3.80	0.74	3.07	5.67	5.56	4.13	3.94	2.28	2.92	42.80
1881	5.17	6.15	6.42	1.74	4.57	3.55	2.84	2.87	0.49	2.41	4.50	4.19	44.90
1882	5.12	4.74	3.64	1.48	4.38	1.96	2.17	1.25	11.64	4.69	1.65	2.65	45.37
1883	3.74	3.67	2.30	1.56	3.12	1.91	3.06	1.83	2.35	5.61	1.50	3.57	34.22
1884	5.69	5.97	4.66	3.18	3.53	4.76	4.81	5.33	1.50	3.57	2.90	7.20	53.10
1885	4.85	3.97	1.20	2.39	3.57	3.28	2.86	8.50	0.67	4.78	4.94	3.54	44.55
1886	5.22	7.43	3.44	3.43	4.19	3.17	4.27	3.23	2.17	3.31	4.33	5.72	49.91
1887	7.07	7.56	4.62	3.00	0.22	6.13	6.99	4.05	1.76	3.32	2.37	4.86	51.95
1888	5.99	4.29	8.78	1.72	4.38	1.86	1.92	6.14	7.81	6.11	6.16	5.55	60.71
1889	5.64	1.81	2.55	4.04	3.33	3.34	13.43	5.12	4.72	5.47	7.03	2.79	59.27
1890	2.84	3.28	7.45	2.84	5.51	2.16	4.16	4.66	5.97	7.52	0.75	4.46	51.60
1891	9.24	6.09	5.96	3.90	1.62	2.70	4.98	3.52	3.46	4.24	3.00	5.08	53.79
1892	5.93	1.59	3.91	1.09	5.27	1.61	2.94	4.32	1.99	1.24	6.44	1.80	38.13
1893	2.47	7.53	5.39	4.33	7.20	2.99	1.56	4.98	2.55	5.54	3.18	4.15	51.87
1894	2.83	4.18	1.71	2.51	5.29	0.39	1.10	1.33	3.55	8.00	5.72	4.85	41.46
1895	5.66	0.99	2.59	4.14	2.12	4.23	2.98	4.57	2.39	4.04	7.36	3.89	44.96
1896	1.80	7.64	5.31	1.09	3.00	4.36	2.72	2.59	5.26	4.31	3.04	2.62	43.74
1897	5.68	3.28	3.83	2.65	5.00	3.52	13.35	7.12	2.44	1.15	6.60	5.85	60.47
1898	4.22	5.98	2.90	5.52	7.70	0.33	4.24	8.87	3.51	8.95	8.06	3.83	64.11
1899	3.92	5.11	8.59	2.29	2.58	2.86	6.22	1.16	4.76	1.71	2.80	2.03	44.03
1900	4.34	9.03	6.39	2.05	3.79	2.45	2.84	2.13	2.45	3.62	5.55	2.86	47.50
1901	1.85	0.65	7.50	12.44	7.02	0.99	4.79	7.62	5.88	4.67	2.42	10.84	66.67
1902	2.25	4.42	7.99	3.51	1.25	3.91	4.26	2.03	7.98	7.53	1.38	7.67	54.18
1903	3.78	4.86	6.59	3.02	0.45	11.37	3.14	6.57	2.05	4.11	2.18	3.83	51.95
1904	3.47	3.08	2.79	6.98	3.41	2.21	2.72	5.48	4.88	2.98	1.84	1.55	41.39
1905	4.07	1.21	3.21	3.13	1.29	5.05	2.39	4.35	3.80	2.75	1.90	4.50	37.65
1906	3.42	3.09	6.51	4.18	6.21	3.07	4.40	3.04	2.74	6.76	2.62	2.32	48.36
1907	4.95	2.11	1.52	2.91	4.15	3.63	1.28	1.14	8.54	5.30	6.70	5.99	48.22
1908	3.80	6.28	3.22	1.56	6.46	1.41	5.32	7.10	1.11	1.57	0.88	3.72	42.43
1909	2.96	7.04	4.18	7.13	2.59	3.46	1.46	5.17	4.83	1.63	2.85	3.45	46.75
1910	6.71	3.76	1.36	3.41	2.69	4.13	2.72	3.00	2.81	0.89	4.47	2.28	38.23
1911	3.06	2.93	3.45	3.77	0.50	2.46	1.87	5.26	2.37	6.63	6.02	3.88	42.20
1912	2.18	3.42	9.03	4.19	5.35	0.72	2.23	4.57	2.72	1.42	4.25	5.18	45.26
1913	2.92	2.50	5.67	5.65	2.86	1.50	1.93	2.10	2.57	10.26	2.80	3.81	44.57
Av.	4.12	4.12	4.66	3.54	3.76	3.37	4.04	4.67	3.64	4.19	3.97	3.97	48.05

RAINFALL AT NEW HAVEN, CONN. Elevation, 107 feet.

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1804	4.76	2.28	4.12	3.60	3.07	2.30	3.32	1.35	4.90	6.07	3.21	4.32	43.30
1805	6.93	1.95	2.20	2.65	3.92	2.71	0.86	3.88	1.65	6.75	3.20	4.10	40.80
1806	3.20	1.87	1.67	2.90	1.82	1.50	3.60	6.80	5.60	0.70	6.15	2.80	38.61
1807	3.80	7.80	3.90	4.75	5.00	2.43	4.32	5.00	1.32	1.45	1.45	4.10	45.32
1808	4.38	2.85	2.70	2.95	9.35	4.08	8.55	0.73	4.37	2.94	2.00	4.50	49.40
1809	4.70	3.14	2.42	3.58	2.23	4.34	4.81	4.38	0.14	5.12	2.39	7.30	44.55
1810	1.46	1.22	2.89	2.67	1.31	4.17	6.88	5.35	1.55	2.03	8.34	1.53	39.40
1811	3.32	5.01	3.69	2.73	1.83	1.89	6.24	5.30	1.88	5.44	4.37	5.96	47.66
1812	4.66	4.28	1.03	3.32	3.51	3.42	4.19	5.55	3.51	4.45	3.03	3.22	44.17
1813	4.54	1.38	5.36	3.68	7.33	4.17	4.04	4.11	4.92	5.86	3.91	4.10	53.40
1814	1.60	7.65	3.71	3.82	6.20	3.00	7.03	9.13	3.22	1.23	7.72	1.75	56.06
1815	3.09	3.33	5.27	3.07	3.87	3.88	6.94	4.90	9.79	0.68	2.19	3.63	50.64
1816	3.68	5.45	2.46	2.72	2.81	3.67	1.15	1.61	6.65	4.14	2.81	0.85	38.00
1817	2.59	4.87	3.27	2.80	1.30	8.90	2.46	4.27	2.74	1.15	5.39	3.64	43.38
1818	2.90	2.30	4.00	4.67	6.36	2.49	3.05	1.63	5.79	1.22	1.53	2.08	38.02
1819	1.16	5.16	5.60	3.94	4.31	1.91	1.44	2.65	3.46	1.26	0.65	2.35	33.89
1820	3.15	3.87	5.36	0.86	5.97	0.96	6.23	2.34	2.22	8.80	3.00	3.43	46.19
1821	4.49	5.28	2.32	4.70	3.44	4.60	1.71	1.00	4.74	5.11	4.28	2.97	44.64
1822	...	...	...	5.78	2.16	2.90	4.26	2.72	4.33	2.28	3.78	...	....
1826	...	...	...	...	...	...	...	...	4.15	5.97	3.67	3.74	....
1827	2.21	3.60	2.57	3.70	4.34	2.67	4.83	6.41	5.40	6.01	6.18	3.46	51.38
1828	...	2.74	3.10	2.30	6.01	3.70	11.10	...	8.90	1.40	3.20	1.20	....
1829	...	4.00	4.43	2.30	3.50	2.96	1.00	...	...	...	...	...	....
1864	...	...	...	...	...	2.36	1.27	2.50	2.90	1.96	4.53	3.31	....
1865	4.74	4.98	4.85	2.39	6.30	2.05	4.29	1.43	0.79	3.59	2.72	3.76	41.89
1866	1.92	5.55	3.62	2.57	5.45	3.38	3.50	6.48	5.10	1.68	3.41	4.32	46.98
1867	2.14	4.60	3.15	1.95	4.34	5.43	1.85	9.73	0.87	6.32	2.41	2.65	45.44
1868	3.16	2.11	2.15	4.70	...	...	...	...	...	...	...	...	....
1873	7.55	3.49	4.05	4.95	6.27	2.07	1.55	9.90	2.12	6.18	4.75	4.44	57.32
1874	4.29	3.86	1.34	7.89	4.92	3.41	4.90	12.99	4.07	1.86	3.44	2.85	55.82
1875	2.72	3.98	3.24	3.28	2.71	3.50	4.42	5.56	2.10	3.18	7.44	1.39	43.52
1876	1.54	4.29	10.15	7.65	3.12	1.76	11.05	1.20	5.34	1.07	4.43	2.38	53.98
1877	2.60	1.07	8.09	3.44	2.14	6.17	2.37	5.69	1.13	10.09	7.11	1.46	51.36
1878	6.80	6.40	4.18	5.08	3.75	2.62	2.53	4.93	7.67	2.33	6.33	5.50	58.12
1879	2.69	3.89	5.82	6.08	3.22	4.62	9.50	9.40	2.13	1.41	2.33	4.41	55.50
1880	3.75	3.80	5.68	3.69	1.24	1.21	4.90	8.14	3.73	4.07	2.82	3.49	46.52
1881	4.79	6.17	10.42	1.71	3.89	5.14	3.53	2.51	1.45	2.78	4.18	4.75	51.32
1882	5.91	4.52	3.59	1.55	5.05	2.74	3.03	0.26	13.43	3.54	1.31	2.99	47.92
1883	3.60	5.00	1.64	2.23	4.52	1.83	5.67	1.26	2.43	5.87	1.56	3.85	39.46
1884	4.63	5.57	4.15	2.36	3.32	5.26	5.89	5.60	1.41	2.49	2.24	6.41	49.33
1885	4.05	3.15	1.19	2.31	2.61	1.43	2.51	8.13	0.77	5.37	3.49	3.31	38.32
1886	3.53	5.95	3.20	3.21	2.74	2.84	4.69	4.56	2.35	1.95	3.83	3.47	42.32
1887	4.24	6.22	4.22	2.75	0.18	5.62	4.66	4.80	2.21	3.24	2.85	3.09	44.08
1888	5.48	3.16	7.46	2.57	6.03	2.15	1.76	7.10	7.68	6.46	4.73	5.68	60.26
1889	4.47	2.08	1.44	4.01	3.81	3.17	17.08	4.38	4.98	3.96	7.78	2.62	59.78
1890	3.07	3.19	6.60	2.89	4.24	3.12	6.59	2.67	5.38	7.63	0.67	2.90	48.95
1891	6.77	5.88	3.68	2.35	1.92	1.90	4.52	3.14	3.96	4.62	2.21	3.74	44.69
1892	5.39	1.56	3.07	1.31	5.11	2.36	4.33	4.99	1.54	0.94	5.46	1.72	37.78
1893	3.47	6.23	4.50	3.84	7.08	2.07	1.89	4.86	2.24	4.75	2.56	3.22	46.71
1894	2.74	4.23	1.15	2.24	4.49	0.49	2.40	1.70	4.63	6.11	4.23	3.33	37.74
1895	5.13	0.99	2.36	3.11	1.70	2.41	3.77	3.91	2.51	3.32	4.84	1.91	35.96

RAINFALL AT NEW HAVEN, CONN. — *Continued.*

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1896	1.82	5.65	5.61	1.19	3.67	2.96	3.86	2.57	3.42	2.91	2.33	2.40	38.39
1897	3.85	2.00	3.66	2.44	5.03	2.47	16.63	6.81	2.42	1 25	5.72	5.61	57.89
1898	4.96	4.55	2.54	4.43	8.03	0.21	5.03	6.65	2.30	7.22	5.69	2.11	53.72
1899	4.33	3.39	7.28	1.79	2.52	2.59	4.17	0.65	3.33	1.78	1.89	1.56	35.28
1900	3.60	6.39	4.21	1.95	3.30	1.79	2.28	0.90	2.10	2.03	4.14	2.14	34.83
1901	1.38	0.54	5.80	9.03	6.38	0.25	4.40	6.92	5.70	2.95	1.61	7.65	52.61
1902	1.83	3.58	4.63	3.40	1.61	4.35	3.26	2.14	5.84	6.41	0.79	6.49	44.33
1903	3.17	3.98	5.09	2.61	0.31	7.41	2.17	6.96	2.20	2.94	1.85	2.53	41.22
1904	2.78	2.52	3.28	6.64	2.94	2.46	2.08	6.27	4.96	2.21	1.95	3.64	41.73
1905	4.14	2.06	2.96	3.42	1.18	5.87	2.86	7.20	5.07	2.21	1.53	4.83	43.33
1906	3.20	2.45	5.67	4.48	4.75	5.14	5.62	1.13	4.82	7.44	2.42	4.18	51.30
1907	3.56	2.91	2.59	3.00	4.42	3.18	1.10	1.21	7.67	4.85	6.97	4.73	46.19
1908	4.18	6.44	3.78	2.15	6.16	1.20	3 94	8.12	0.88	1.58	0.83	4.07	43.33
1909	3.38	6.98	4.20	6.66	2.19	3.47	1.42	3.49	3.93	1.76	1.51	4.70	43.69
1910	7.28	4.37	1.16	3.35	4.34	4.03	2.26	3.21	1.83	1.15	4.56	2.30	39.84
1911	3.20	3.45	4.48	4.31	0.74	2.73	2.17	5.57	2.33	7.44	6.40	4.04	46.86
1912	3.08	2.91	9.15	4.56	6.34	0 50	2.14	3.22	2.32	1.22	3.37	6.04	44.85
1913	3.67	3.77	5.33	5.41	2.30	1.09	1.69	3.40	2.52	10.64	2.74	4.28	46.84
Av.	3.78	3.98	4.11	3.51	3.88	3.07	4.32	4.57	3.64	3.86	3.61	3.64	45.97

RAINFALL AT NEW LONDON, CONN. Elevation, 47 feet.

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1871	1.45	1.75	6.23	2.67	2.74	4.58	1.39	3.71	1.35	8.35	5.50	2.78	42.50
1872	2.46	0.96	3.69	2.30	3.16	2.78	5.35	6.06	6.98	3.77	5.46	4.04	47.01
1873	6.38	3.31	2.24	2.88	5.38	0.58	1.38	3.69	2.38	5.62	5.52	2.90	42.26
1874	2.65	2.85	2.96	10.85	5.26	2.63	5.05	16.44	2.08	0.91	3.67	4.24	59.59
1875	4.13	4.09	4.02	2.95	2.68	3.21	6.36	3.55	4.11	4.06	4.16	1.47	44.79
1876	1.83	4.83	7.01	5.74	2.85	0.68	5.65	0.48	5.00	1.44	5.26	2.43	43.20
1877	3.67	1.60	10.96	2.52	2.11	7.70	3.98	4.90	1.21	6.78	5.15	0.73	51.31
1878	5.18	1.22	2.22	1.63	0.98	2.76	3.11	5.44	1.52	3.75	5.80	5.74	39.35
1879	3.32	2.81	5.96	6.48	1.47	4.76	6.04	7.75	4.70	1.16	2.22	4.38	51.05
1880	2.44	3.43	4.97	3.44	1.39	2.16	5.59	6.53	3.06	4.14	2.05	4.03	43.23
1881	**4.89**	**6.13**	**8.01**	**1.64**	**3.64**	**4.26**	**3.39**	**2.86**	**1.16**	**2.75**	**4.54**	**4.20**	47.47
1882	**4.96**	**4.53**	**4.00**	**1.81**	**3.71**	**2.68**	**2.59**	**1.73**	**10.44**	**3.84**	**0.94**	**3.24**	44.47
1883	**3.30**	**4.73**	**1.72**	**2.12**	**4.17**	**1.70**	**5.58**	**1.24**	**2.81**	**6.01**	**1.82**	**3.14**	38.34
1884	**4.81**	**5.84**	**4.07**	**2.75**	**3.07**	**5.58**	**5.15**	**6.42**	**1.11**	**2.41**	2.78	7.36	51.35
1885	5.44	4.03	1.55	3.34	5.02	2.12	2.67	7.69	1.44	6.16	5.69	3.92	49.07
1886	7.36	11.98	4.64	3.63	3.45	2.14	3.82	5.04	3.69	4.14	4.57	4.37	58.83
1887	4.73	5.88	4.65	3.63	1.36	4.69	5.47	4.19	2.32	4.28	2.19	4.62	48.01
1888	4 78	2.33	5.96	2.66	4.90	1.28	1.35	3.81	7.32	3.77	5.46	2.39	46.01
1889	3.54	2.47	2.37	4.02	3.84	4 13	6.91	4 15	4.93	5.25	6.19	1.90	49.70
1890	3.31	2.40	8.60	4.86	4.51	2.94	3.07	2.43	5.51	6.43	0.86	3.93	48.85
1891	6.36	6.46	3.99	3.12	1.42	2.81	3.37	4.99	2.60	6.50	3.37	3.74	48.73
1892	4.82	1.71	4.33	1.86	4.07	2.46	2.57	3.45	2 04	0.98	4.79	1.67	34.75
1893	2.46	5 93	5.38	3.12	5.02	3.60	1.51	3.69	2 29	2.20	2.42	4.10	41.72
1894	3.50	3.80	2.07	2.62	3.53	0.53	0.44	2 91	2.59	7.21	4.75	5.25	39.20
1895	5.54	0.43	4 12	4.51	4.32	2.16	5.83	2 41	1 68	4 71	3.75	1.40	40.86

RAINFALL AT NEW LONDON, CONN. — *Continued.*

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1896	0.50	3.07	2.96	1.50	2.17	1.72	3.64	3.60	2.49	3.37	2.28	2.75	30.05
1897	4.28	1.45	2.48	3.69	4.76	2.48	6.22	5.06	3.74	1.20	7.85	4.55	47.76
1898	4.45	4.01	3.66	4.49	8.12	1.09	4.72	7.69	3.33	8.47	7.43	1.85	59.31
1899	4.02	6.91	7.59	1.45	2.52	2.60	5.29	2.59	4.32	1.87	1.58	1.73	42.47
1900	4.25	4.72	4.25	2.07	4.84	1.90	1.46	0.89	4.03	1.59	5.15	1.86	37.01
1901	1.55	0.58	5.33	5.22	4.75	1.20	2.38	1.35	4.92	1.60	2.88	6.98	38.74
1902	2.09	3.85	2.22	3.20	1.76	2.77	2.23	1.63	4.63	4.21	0.59	5.67	34.85
1903	2.94	4.04	4.39	3.40	0.54	4.44	2.00	5.70	1.31	2.14	1.29	2.23	34.42
1904	4.98	2.93	2.30	4.87	2.22	2.14	1.69	4.03	5.00	1.96	2.63	4.18	38.93
1905	3.74	1.66	2.54	3.39	1.31	5.72	2.76	5.12	3.54	2.27	2.20	5.00	39.25
1906	2.88	3.28	4.13	3.82	5.34	5.90	6.41	2.10	3.17	7.42	2.53	4.21	51.19
1907	3.71	2.81	2.98	2.51	4.05	3.06	1.90	0.99	5.93	4.74	7.23	5.51	45.42
1908	4.96	5.84	4.20	2.05	4.09	1.82	3.11	7.82	1.57	3.76	0.32	4.38	43.92
1909	3.59	7.18	4.05	6.24	2.90	2.80	2.34	2.95	5.04	1.67	3.29	2.98	45.03
1910	5.78	3.69	1.46	1.98	3.21	3.83	3.10	2.15	2.21	2.58	4.60	2.77	37.36
1911	4.32	2.56	3.18	2.98	0 74	1.89	2.18	6.98	2.27	3.22	6.52	3.40	40.24
1912	2.88	2.64	6.90	4.35	3.45	0.42	2.48	3.33	2.65	1.40	2.47	5.89	38.86
1913	3.69	3.38	3.76	6.91	1.82	1.04	1.71	2.27	4.13	7.84	2.99	3.03	42.57
Av.	3.91	3.72	4.28	3.52	3.32	2.83	3.56	4.23	3.45	3.91	3.78	3.65	44.16

RAINFALL AT NEWTOWN, CONN. Elevation, 600 feet.
(Hawleyville.)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1899	3.70	5.46	5.70	1.72	2.13	4.33	4.91	1.19	5.67	1.48	2.10	2.93	41.32
1900	3.68	9.03	5.95	1.90	5.98	4.31	3.02	2.62	3.00	4.25	6.82	2.77	53.33
1901	1.89	0.60	8.35	10.25	7.23	1.01	5.64	7.81	5.02	4.14	1.83	12.60	66.37
1902	3.22	4.32	4.89	3.99	2.36	4.19	5.08	3.14	6.25	6.33	0.84	5.44	50.05
1903	4.39	4.51	5.16	2.50	1.61	10.38	2.56	7.41	6.17	6.32	2.07	4.54	57.62
1904	4.49	3.34	4.25	4.60	4.10	2.38	3.63	4.00	7.26	3.69	1.56	3.37	46.67
1905	6.48	1.71	2.70	3.14	1.24	4.02	5.12	5.96	3.13	2.88	2.17	3.62	42.17
1906	3.00	1.94	4.17	5.59	4.21	5.32	6.83	2.17	2.96	4.54	1.85	2.86	45.44
1907	3.80	2.20	1.23	3.60	5.95	4.91	2.13	1.73	9.68	6.67	6.19	4.75	52.84
1908	3.92	5.04	4.17	2.35	7.16	1.58	2.44	6.25	1.59	2.02	0.88	3.90	41.30
1909	3.36	7.56	4.54	7.69	2.67	2.51	2.21	4.91	3.74	1.16	2.10	3.73	46.18
1910	6.22	3.98	1.42	4.42	3.29	3.33	4.46	4.59	2.17	0.78	5.04	**2.56**	42.26
1911	**2.92**	**2.69**	3.97	3.23	3.17	3.27	2.54	7.78	2.24	7.27	4.47	3.25	46.80
1912	2.70	3.07	8.18	4.48	4.79	0.86	2.70	3.00	4.16	2.93	3.93	4.25	45.05
1913	3.43	2.49	5.47	5.96	3.54	1.33	2.25	3.43	3.80	8.72	3.50	3.02	46.94
Av.	3.82	3.86	4.68	4.36	3.96	3.58	3.70	4.40	4.46	4.21	3.02	4.24	48.29

RAINFALL AT NORWALK, CONN. Elevation, 116 feet.

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1892	3.52	1.26	2.48	1.34	5.13	1.48	4.75	5.50	2.30	0.68	8.86	1.54	38.84
1893	2.35	7.46	4.10	3.90	6.84	2.10	3.64	6.57	2.38	5.16	3.24	3.79	51.53
1894	1.64	3.17	1.22	1.82	4.88	1.49	0.83	1.23	5.52	5.86	5.55	4.11	37.32
1895	4.35	0.49	2.45	2.93	1.79	2.10	4.68	4.62	1.99	3.96	4.07	2.75	36.18
1896	1.35	7.08	6.87	0.77	5.33	4.26	4.71	2.53	5.42	2.22	2.41	0.92	43.87
1897	3.90	2.45	3.74	2.41	7.34	2.67	10.12	3.15	2.24	1.79	6.06	5.49	51.36
1898	4.52	3.39	3.23	3.74	8.53	0.79	7.27	7.15	1.40	8.29	6.04	3.26	57.61
1899	4.28	4.65	6.69	2.11	2.65	3.06	5.91	0.37	4.80	1.42	1.92	2.32	40.18
1900	4.11	5.74	4.08	1.95	3.62	2.03	4.30	2.25	3.44	3.47	4.92	2.54	42.45
1901	1.81	0.67	6.59	8.60	8.34	1.29	4.89	8.97	3.08	3.48	1.55	8.58	57.85
1902	2.57	4.62	5.71	3.78	2.60	4.72	2.45	3.09	7.87	7.64	1.30	7.02	53.37
1903	4.45	4.93	5.83	3.22	0.07	10.54	3.03	10.05	2.61	5.07	1.38	4.32	55.50
1904	3.26	3.05	3.88	4.22	1.87	3.19	2.82	8.45	4.46	2.29	2.14	2.78	42.41
1905	4.78	1.42	3.45	3.14	0.69	2.85	3.91	7.37	7.53	2.69	2.38	4.37	44.58
1906	2.96	2.12	5.79	6.32	4.87	1.90	4.96	3.09	3.02	5.66	1.71	4.78	47.18
1907	3.64	3.40	2.82	2.99	4.46	3.56	1.29	1.48	5.98	5.38	5.98	4.76	45.74
1908	3.38	6.02	3.29	2.28	6.67	0.56	6.90	11.38	0.98	1.27	0.95	3.29	46.97
1909	3.69	5.20	3.65	7.80	2.35	1.68	1.96	6.23	3.52	0.97	1.76	3.58	42.39
1910	6.48	3.46	1.32	3.61	3.18	5.08	1.40	1.36	1.42	1.33	3.93	2.31	34.88
1911	2.75	3.54	4.13	3.65	1.60	3.37	2.24	5.18	3.29	8.40	5.42	3.33	46.90
1912	2.01	2.29	8.55	3.62	4.29	1.17	2.17	4.68	2.94	2.50	4.46	5.16	43.84
1913	3.93	2.74	5.86	5.44	3.01	0.75	1.04	7.45	3.58	9.09	2.35	3.43	48.67
Av.	3.44	3.60	4.35	3.62	4.09	2.76	3.87	5.10	3.63	4.03	3.56	3.81	45.89

RAINFALL AT NORWICH, CONN. Elevation, 150 feet.

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1871	2.24	2.96	5.16	2.10	2.26	3.80	1.97	5.16	1.10	6.96	6.38	3.58	43.67
1872	3.60	1.80	1.51	1.83	3.31	3.66	5.39	6.48	7.61	4.38	6.12	5.18	50.87
1873	9.01	6.73	2.81	4.76	6.37	0.27	2.25	6.99	3.18	7.90	5.71	6.37	62.35
1874	5.08	5.34	1.80	8.98	5.09	3.67	4.48	13.30	2.91	1.16	3.43	3.20	58.44
1875	3.55	5.63	6.80	4.47	3.16	3.48	2.28	6.41	2.61	5.52	7.57	1.20	52.68
1876	1.74	5.23	11.79	5.25	2.96	1.36	10.00	0.85	6.86	1.51	5.33	4.34	57.22
1877	3.91	1.42	13.18	3.16	2.18	7.80	2.37	7.15	0.46	9.45	9.14	2.60	62.82
1878	5.72	3.84	3.99	6.75	2.95	3.38	2.92	3.21	2.08	4.22	5.49	5.43	49.98
1879	3.14	4.46	3.89	5.05	2.83	3.27	5.42	7.51	2.86	0.83	2.46	3.46	45.18
1880	1.75	3.10	3.59	4.12	0.62	1.38	5.44	6.29	3.60	3.61	2.24	2.78	38.52
1881	4.99	6.08	5.60	1.56	3.38	3.38	3.25	3.20	0.87	2.71	4.90	3.65	43.57
1882	4.01	4.53	4.41	2.07	2.36	2.62	2.14	3.19	7.45	4.14	0.56	3.48	40.96
1883	3.00	4.45	1.79	2.00	3.81	1.57	5.48	1.22	3.19	6.14	2.08	2.42	37.15
1884	4.98	6.10	3.98	3.13	2.82	5.90	4.41	7.24	0.80	2.32	2.37	7.40	51.45
1885	6.18	2.85	1.11	2.03	3.55	1.62	2.30	7.32	0.50	4.78	4.39	3.55	40.18
1886	6.51	9.52	4.20	2.65	2.87	2.13	3.97	3.79	1.92	3.95	4.37	4.58	50.46
1887	6.77	5.40	4.64	2.60	1.80	5.11	5.50	4.12	2.38	3.29	2.08	4.39	48.08
1888	6.78	3.29	8.37	2.21	5.67	1.22	1.03	6.07	7.85	3.78	6.49	5.00	57.76
1889	4.80	1.92	1.81	4.33	3.72	2.13	9.05	3.78	4.54	5.80	7.16	2.12	51.16
1890	2.86	2.54	7.12	4.18	3.75	2.13	2.53	3.67	5.20	7.02	0.83	4.62	46.45
1891	7.99	3.78	4.90	4.54	1.57	7.31	2.37	5.94	2.61	5.23	3.13	3.38	52.75
1892	4.69	1.22	2.45	1.73	4.38	1.93	2.83	3.37	2.51	1.56	5.19	1.08	32.94
1893	2.35	8.61	5.18	3.11	5.60	2.32	0.89	3.77	2.65	3.09	3.07	3.43	44.07

RAINFALL AT NORWICH, CONN. — *Continued.*

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1894	1.68	1.83	1.58	3.03	3.77	0.78	1.23	1.63	1.83	4.72	3.70	4.01	29.79
1895	4.73	0.98	2.92	5.09	3.25	3.12	5.92	5.03	2.22	8.12	4.43	2.30	48 11
1896	0.92	7.00	3.26	1.00	3.18	2.37	2.72	3.90	4.20	3.24	3.13	1.39	36 31
1897	2.99	1.58	2.83	3.20	3.71	2.39	6.15	8.23	2.53	0.84	7.58	4.95	46.98
1898	3.37	3.63	2.52	5.18	7.39	2.88	6.17	9.69	2.42	7.03	4.51	2.08	56.87
1899	4.68	2.00	7.61	2.44	1.79	3.01	5.31	2.51	6.51	0.79	2.85	2.08	41.58
1900	3.94	5.74	5.11	2.19	5.08	1.64	2.62	1.22	2.66	2.86	7.40	2.85	43.31
1901	1.43	0.13	8.21	7.46	5.58	1.87	4.47	2.87	5.16	2.00	2.32	9.07	50.57
1902	2.11	2.55	5.07	3.35	0.77	3.23	3.71	1.84	5.35	5.50	1.66	6.40	41.54
1903	4.08	6.41	7.78	3.19	0.31	8.18	3.74	4.27	1.05	2.78	1.70	3.33	46.82
1904	3.43	3.23	2.78	7.99	2.34	2.24	1.94	4.45	5.85	2.15	2.07	3.74	42.21
1905	2.90	1.77	2.95	3.91	1.99	5.20	2.24	4.00	6.26	2.31	2.59	4.41	40.53
1906	4.10	2.85	5.04	3.52	5.17	4.67	4.88	1.54	2.16	8.11	2.05	4.63	48 72
1907	2.81	1.15	1.60	2.72	3.97	2.71	1.42	1.04	5.85	4.48	5.84	5.70	39.29
1908	3.80	5.35	2.73	2.18	4.46	2.60	2.78	5.87	0.93	2.00	0.66	3.92	37.28
1909	2.71	6.82	3.05	5.01	2.03	1.07	1.03	1.85	5.53	1.40	2.90	2.95	36.35
1910	4.70	3.64	0.84	2.47	2.17	2.81	2.90	4.34	1.73	1.73	3.44	2.52	33 29
1911	3.82	2.20	3.72	3.10	0.69	2.00	2.05	4.33	2.07	3.11	6.73	3.37	37 19
1912	2.43	2.40	8.06	4.33	4.49	0.60	5.44	2.75	2.56	1.39	3.82	6.74	45 01
1913	3.92	2.79	4.79	6.15	2.09	1.08	1.90	2.71	4.37	7.03	2.23	3.69	42.75
Av.	3.96	3.83	4.48	3.72	3.29	2.93	3.65	4.51	3.42	3.98	4.00	3.89	45.66

RAINFALL AT SIMSBURY, CONN. Elevation, 300 feet.
(West Simsbury.)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1890	2.38	3.70	5.30	2.35	4.22	2.92	4.77	5.23	5.72	6.49	0.61	4.03	47 72
1891	7.94	3.96	4.32	2.73	1.84	2.84	5.11	4.92	1.46	2.45	3.26	4.89	45.72
1892	5.18	1.19	5.17	0.66	6.17	3.17	4.47	5.38	2.01	0.90	5.62	1.28	41.20
1893	3.53	5.94	3.92	3.77	6.75	3.52	2.37	4 29	2.83	5.01	2.43	3.99	48.35
1894	2.56	2.62	1.69	2.22	5.47	0.59	1.95	0.75	5.71	6.34	4.16	4.09	38.15
1895	3.96	1.19	2.30	3.57	1.56	3.73	3.68	5.44	2.68	5.66	4.12	3.96	41.85
1896	1.75	7.67	5.35	1.07	2.86	3.63	4 57	3.02	5.96	3.16	2.93	1.54	43.51
1897	4.42	3.27	3.17	2.34	4.74	4.82	16.21	5.09	1.82	1.13	6.39	6.13	59.53
1898	4.47	6.00	2.14	3.69	6.18	2.23	4.59	7.38	2 07	4.99	6.48	3.42	53 64
1899	3.36	3.63	6.76	2.04	2.04	6.71	6 60	3.79	4.29	1.87	1.94	2.54	45.57
1900	3.06	9.06	5.77	1.68	5.44	2.79	3.99	2.67	2.32	3.64	5.98	2.29	48.69
1901	1.41	0.52	5.52	11.10	7.15	1.60	2.54	5.82	5.16	4.26	2.24	8.06	55.38
1902	2.77	5.06	4.95	4.39	1.61	3.52	7.23	3.50	5.78	6.15	0.98	7.32	53.26
1903	4.02	5.18	5.13	2.95	0.73	9.79	3.79	7.21	4.57	3.70	3.09	4.80	54 96
1904	3.53	1.88	5.18	4.35	2.16	2.46	3.47	5.29	5.29	2.90	1.22	3.13	40 86
1905	6.70	1.39	2.74	2.16	0.83	3.53	3.13	3.83	4.76	2.15	1.91	3.12	36 25
1906	2.21	1.81	4.62	3.84	4.24	1.96	7.38	1.80	3.29	5.75	2.78	4.03	43 71
1907	2.93	2.45	1.14	2.42	3.99	3.30	1.17	1.56	9.83	6.31	5.38	4.46	44.94
1908	3.81	5.91	3.11	2.45	5.48	2.38	2 31	3.46	1.17	1.78	0.83	3.02	35.71
1909	3.26	5.81	4.42	7.52	2.40	1.58	2.15	4.05	4.07	1.48	1.99	4 00	42.73
1910	6.27	4.33	0.64	4.04	2.61	4.10	2.39	2.59	3.99	0.96	4.60	2.15	38.67
1911	2.60	2.61	3.66	2.51	1.86	2.75	3.68	6.14	5.05	9.31	3.83	2.82	46.82
1912	2.08	2.99	5.84	3.69	3.73	0.57	3.01	4 23	2.85	3.44	4.22	4.32	40 97
Av.	3.66	3.83	4.04	3.37	3.65	3.24	4.37	4.24	4.03	3.90	3.35	3.89	45.57

RAINFALL AT SOUTHINGTON, CONN. Elevation, 140 feet.

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1871	2.93	3.91	5.84	2.35	5.05	5.11	2.45	8.72	1.40	6.05	4.15	2.77	50.73
1872	1.87	2.87	4.04	1.54	3.13	3.70	5.07	6.09	3.29	2.51	4.90	3.35	42.36
1873	5.70	3.55	2.54	3.63	5.30	0.48	4.22	9.42	2.50	4.45	4.16	5 75	51.70
1874	6.47	3.50	1.20	7.08	3.56	2.76	6.36	6.28	2.75	0.87	2.74	1.70	45.27
1875	3.31	5.37	5.86	4.14	1.90	3.58	4.34	7.41	1.55	2.91	4.73	1.24	46.34
1876	1.47	5.63	7.05	4.17	3.65	1.81	6.83	1.04	2.99	1.78	3.57	5.23	45.22
1877	3.30	1.15	7.27	2.13	0.51	7.42	4.55	5.18	1.27	7.93	5.51	1.05	47.27
1878	4.73	5.24	3.06	4.95	2.85	3.26	2.21	3.84	3.50	2.00	5.63	5.58	46.85
1879	2.09	3.78	5.29	4.59	2.53	4.27	5.61	7.22	2.22	1.00	1.45	3.44	43.49
1880	3.68	3.38	3.42	2.63	0.71	2.81	6.46	3.25	3.59	2.66	2.35	2.38	37.32
1881	4.47	5.26	5.76	1.15	5.30	2.95	2.51	2.80	0.38	1.74	4.61	4.18	41.11
1882	3.99	3.62	2.87	0.85	2.33	1.28	3.40	0.40	10 13	2.71	1.53	1.06	34.17
1883	2.91	4.43	1.85	1.15	3.88	0.45	2.68	1.66	2.73	4.47	1.11	2.70	30.02
1884	4.18	4.76	3.49	3.05	2.46	2.06	4.08	4.18	0.53	2.85	2.35	6.45	40.44
1885	4.20	4.08	0.87	1.92	1.59	2.05	2.28	9.55	0.93	3.55	3.53	3.43	37.98
1886	3.93	5.47	3.35	3.57	2.28	2.25	3.80	2.35	2.00	1.60	3.98	3.89	38.47
1887	4.98	5.18	4.78	2.00	0.03	5.18	3.95	6.03	0.46	3.30	2.03	5.30	43.22
1888	4.78	4.65	7.40	1.86	3.15	1.53	1.85	5.15	7.80	4.70	4.33	6.13	53.33
1889	5.65	1.71	1.63	3.96	3.66	4.11	12.13	3.13	4.44	4.58	7.10	2.54	54.64
1890	2.15	3.88	7.18	3.33	5.77	3.20	2.91	3.37	3.61	6.94	0.70	4.14	47.18
1891	10.81	5.35	5.95	3.16	1.34	1.10	3.65	2.93	3.70	2.95	2.65	5.30	48.89
1892	5.50	1.28	4.00	1.05	5.63	1.10	2.25	5.15	2.43	1.15	5.38	1.30	36.22
1893	3.11	6.71	5.56	3.68	6.87	3.60	2.10	6.10	2.04	5.60	2.65	3.90	51.92
1894	2.21	3.85	1.21	2.35	6.85	0.65	2.00	2.15	5.60	6.30	4.50	4.05	41.72
1895	4.33	1.13	2.13	3.70	2.15	3 20	3.20	5.43	3.47	4.05	6.93	3.12	42.84
1896	1.60	6.20	6.00	1.10	2.91	5.30	3.23	3.20	6.13	3.30	3 10	2.03	44.10
1897	4.68	2.65	2.55	2.03	5.50	4.55	19.90	6.33	2.65	0.85	5.50	6.35	63.54
1898	3.95	4.90	2.38	3.23	5.56	0.53	3.33	8.50	2.63	6.09	7.68	1.60	50.38
1899	4.03	3.78	6.66	1.90	1.75	2.23	5.62	0.45	4.13	2.35	2.15	1.68	36.73
1900	3.35	7.70	5.80	1.60	5.15	3.13	2.70	1.90	2.20	2.95	5.70	2.45	44.63
1901	1.60	0.90	6.80	9.65	7.00	0.50	6.30	5.95	6.60	3.55	2.25	9.80	60.90
1902	2.10	4.55	6.45	3.40	1.65	3.70	5.65	3.25	7.70	6.10	0.65	8.55	53.75
1903	3.80	4.20	6.60	2.50	0.50	12.10	3.65	6.90	3.00	3.00	2.15	4.10	52.50
1904	3.70	2.65	2.65	5.20	2.63	2.63	4.85	5.45	6.90	2.55	1.35	2.80	43.36
1905	4.25	1.80	2.90	2.12	1.45	4.90	2.95	4.75	4.05	1.50	2.05	4.50	37.22
1906	2.30	1.90	5.40	4.40	4.80	4.05	5.00	1.90	2.35	6.05	2.40	2.60	43.15
1907	3.95	2.10	1.10	2.75	3.15	3.55	1.15	1.18	11.90	5.30	6.15	5.55	47.83
1908	3.30	5.70	3.60	1.10	7.40	1.20	4.65	7.10	1.40	2.15	1.00	3.90	42.50
1909	2.80	5.48	3.70	7.20	2.40	4.15	2.50	3.60	3.95	1.50	2.95	3.75	43.98
1910	7.60	3.80	1.00	4.00	2.68	3.45	2.30	3.05	1.20	0.55	4.75	2.65	37.03
1911	3.40	2.80	4.60	3.60	0.20	2.80	2.65	7.20	2.15	8.80	4.35	3.45	46.00
1912	2.35	3.70	8.45	4.17	5.00	0.70	3.30	2.80	2.30	1.65	4.05	5.10	43.57
1913	3.10	2.93	6.30	3.80	3.95	2.15	1.20	3.00	3.95	10.30	2.85	3.55	47.08
Av.	3.83	3.90	4.34	3.20	3.40	3.06	4.23	4.54	3.50	3.66	3.57	3.82	45.05

RAINFALL AT THOMPSON, CONN. Elevation, 400 feet.
(North Grosvenordale.)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1891	8.67	5.45	5.35	3.58	1.91	3.10	3.91	4.03	2.22	3.33	3.25	3.89	48.69
1892	5.38	1.70	3.16	0.59	6.00	3.79	4.54	5.00	1.80	1.52	5.61	1.29	40.38
1893	2.40	5.89	3.99	3.24	6.03	1.75	1.27	4.03	2.44	4.55	2.40	3.50	41.49
1894	2.66	2.48	0.94	2.84	4.18	0.18	1.51	2.86	1.26	3.68	3.89	3.69	30.17
1895	4.45	0.65	3.18	4.66	2.55	4.74	3.43	3.60	3.40	9.12	9.69	5.62	55.09
1896	2.56	8.93	6.64	1.21	2.18	3.01	2.18	2.47	7.78	2.94	3.22	3.09	46.21
1897	4.92	4.51	4.99	2.42	5.71	2.99	9.09	5.66	1.97	1.03	7.24	5.53	56.06
1898	7.43	3.17	2.41	4.34	3.02	2.31	7.88	5.20	2.93	6.10	6.36	2.99	54.14
1899	4.51	5.54	6.53	4.59	1.85	3.81	5.62	1.26	4.40	1.19	2.47	2.21	43.98
1900	5.04	7.72	6.53	2.75	5.84	3.66	4.16	1.57	2.09	4.10	6.30	2.46	52.22
1901	2.01	1.17	7.17	7.23	5.12	1.50	4.32	5.01	4.17	3.36	2.49	10.43	53.98
1902	2.49	5.91	5.47	2.86	1.45	3.91	7.34	3.59	3.94	5.66	0.92	7.02	50.56
1903	3.93	5.54	8.14	3.23	0.49	7.33	3.51	4.59	1.70	3.11	2.05	4.10	47.72
1904	5.48	2.89	3.71	7.62	1.88	2.20	2.22	6.61	6.72	2.01	1.67	3.16	46.17
1905	2.93	1.85	3.31	2.88	1.52	3.93	0.76	4.03	5.88	1.83	2.55	4.28	35.75
1906	2.91	2.54	4.68	2.72	6.46	3.10	3.96	1.96	2.04	4.08	2.04	3.34	39.83
1907	2.93	2.79	1.37	2.26	2.95	3.04	1.30	0.84	8.71	5.05	5.63	3.17	40.04
1908	1.18	3.77	2.27	1.14	2.77	2.31	4.26	7.70	1.03	1.48	0.88	3.41	32.20
1909	2.82	5.41	3.07	5.41	2.57	2.31	1.40	2.35	4.40	1.15	1.73	2.71	35.33
1910	4.01	3.67	0.81	3.03	1.66	3.41	0.91	1.32	1.79	1.49	2.61	1.49	26.20
1911	2.69	1.71	2.62	2.25	0.35	1.49	3.61	3.46	3.06	2.44	3.21	3.68	30.57
1912	2.34	1.66	6.56	4.64	5.07	0.67	4.52	5.22	1.37	1.76	3.58	5.52	42.91
1913	3.70	4.72	5.94	4.93	3.89	2.79	1.76	3.79	3.98	6.73	3.13	3.34	48.70
Av.	3.80	3.90	4.30	3.50	3.28	2.93	3.63	3.74	3.41	3.38	3.60	3.91	43.41

RAINFALL AT TORRINGTON, CONN. Elevation, 25 feet.

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1902	2.12	4.09	3.80	4.19	2.01	4.52	8.22	5.39	5.99	5.91	0.95	6.37	53.56
1903	3.92	4.55	4.48	2.62	0.82	10.19	4.80	5.66	2.95	4.50	3.09	3.26	50.84
1904	2.90	1.70	3.05	4.21	3.02	3.62	4.97	5.82	7.11	2.59	0.94	2.68	42.61
1905	7.08	1.31	3.39	2.54	1.13	3.68	4.13	4.69	5.11	2.73	2.93	3.58	42.30
1906	2.31	2.01	4.74	3.59	4.87	2.31	5.93	2.36	3.22	5.53	1.68	2.27	40.82
1907	2.98	1.95	1.98	2.92	4.49	3.40	2.16	4.64	9.84	7.71	5.22	5.36	52.65
1908	3.69	4.92	2.63	3.15	4.65	2.14	4.01	3.03	1.78	1.52	0.33	3.17	35.02
1909	3.78	5.80	3.68	7.49	3.09	2.34	3.28	4.14	3.91	1.33	2.90	2.79	44.53
1910	...	...	...	...	...	...	...	...	...	...	...	...	....
1911	2.58	2.07	...	...	...	...	5.85	...	...	7.47	3.24	2.58	....
1912	1.71	2.77	...	4.17	...	...	...	3.45	2.58	3.54	3.86	4.46	....
1913	3.35	2.52	6.69	5.69	...	...	...	...	4.13	10.08	3.46	3.61	....
Av.	3.60	3.29	3.47	3.84	3.01	4.02	4.69	4.47	4.99	3.98	2.25	3.68	45.29

RAINFALL AT VOLUNTOWN, CONN. Elevation, 260 feet.

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1885	4.60	3.30	1.30	2.35	3.52	1.45	3.30	6.55	0.85	5.20	5.17	5.35	42.94
1886	6.40	11.25	3.95	2.52	3.25	1.65	2.37	4.00	2.10	4.70	4.30	6.15	52.64
1887	7.00	6.20	3.45	3.80	2.00	5.00	5.80	3.51	2.57	2.95	2.30	5.65	50.23
1888	6.75	4 20	8.45	2.45	4.80	0.95	1.75	4.95	8.25	4.46	8.39	4.84	60.24
1889	6.32	2.15	2.85	4.47	3 82	2.77	9.35	5.38	7.07	4.30	7.13	3.05	58.66
1890	3.14	2.55	7.41	5.38	3.65	3.26	2.79	4.67	4.91	8.47	1.10	5.03	52.36
1891	8.20	6.52	4.85	5.31	2.03	1.97	2.56	5.08	4.10	6.82	3.57	3.36	54.37
1892	5.77	1.25	3.72	1.82	4.58	1.97	3.00	3.37	2.83	2.36	6.54	1.62	38.83
1893	3.10	8.46	5.39	4.01	7 10	2.57	1.48	4.14	2.22	3.83	3.75	5.01	51.06
1894	3 84	3.72	1.65	4 12	4 25	1.42	1.83	2.22	2.30	5.64	4.45	4.47	39.91
1895	5.61	1.02	3.37	4.96	3.52	3.41	6.37	4.46	1.76	6.14	7.93	3.36	51.91
1896	2.10	6.45	5.49	1.50	3.39	2.92	3.89	2.77	6.25	3.05	4.17	2.20	44.18
1897	5.05	2.46	3 40	3.66	4 46	3.66	8.53	5.58	1 82	0.80	8.17	6.31	53.90
1898	4.66	5.12	3.08	5.93	6.45	3.44	5.73	7.28	2.65	9.33	5.14	2.03	60.84
1899	3.86	4.60	7.90	2.64	1.52	2.59	4.58	2.22	8.41	1.43	2.75	2.38	44.88
1900	4.80	8.06	6.78	2.43	4.48	2.23	2.58	2.00	3.10	2.80	6.63	2.71	48.60
1901	2.24	1.25	8.84	9 61	6.08	2.33	3.96	3.33	4.91	1.85	2.99	10 74	58.13
1902	2.65	6.72	6.87	4.07	1.21	3.97	4.19	1.67	5.36	4.67	1.45	6.38	49.21
1903	4.84	6.80	7.69	3.67	0.46	6.88	2.94	3.79	1.13	3.70	1.92	4.35	48.17
1904	4.44	3.64	2.24	6.92	3.30	3.53	1.90	4.31	5.60	1.91	2.03	3.43	43.25
1905	2.89	2.05	2.81	3.38	1.76	5.81	1.58	4.23	6.42	2.46	1.79	5.05	40.23
1906	3.48	3.02	4.67	4.95	5.25	1.96	8.17	3.39	2.19	7.49	1.65	4.23	50.45
1907	4.05	2.18	1 84	3 11	4 89	2.15	1.05	1.17	6.81	3.97	5.83	5.66	42.71
1908	3.98	6.73	3.32	1.90	4.49	2.68	3.90	5.91	1.18	2.63	0.85	4.58	42.15
1909	3.42	7.28	3.67	5.07	2.24	1.35	**1.03**	1.25	3.79	1.67	2.61	3.45	36.83
1910	4.53	3.02	**0.84**	2 37	2.57	3 54	2 90	3.31	2.04	1.66	4.03	3.24	34.05
1911	4 16	2.70	3.62	3.81	**0.69**	**2.00**	**2.05**	**4.33**	**2.07**	**3.11**	**6.73**	**3.37**	38.64
1912	3 83	2.37	7.42	5.01	3.43	0.66	2.81	2.94	2.25	1.47	3.46	6.23	41.88
1913	3.86	3.21	4.38	6.43	1.90	1.39	1 61	3.26	3.15	6.54	2.30	3.94	41.97
Av.	4.47	4.42	4.52	4.06	3.48	2.74	3.59	3.83	3.73	3.98	4.11	4.42	47.35

RAINFALL AT WALLINGFORD, CONN. Elevation, 130 feet.

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1856	...	...	...	4.10	6.85	3.07	2.93	11.68	3.22	1.98	2.67	6.61	...
1857	4.39	...	2.47	7.11	7.76	3.23	8.29	5.62	3.17	5.88	2.06	4.38	...
1858	3.13	1.92	1.57	3.87	2.62	5.08	3.26	4.02	5.18	3.29	3.23	4.47	41.64
1859	6.94	4.24	8.45	3 76	4.73	6.25	2.58	6.12	5.63	1.91	2.49	4.01	57.11
1860	2.38	3.13	2.62	2.11	4.04	1.64	2.72	5.53	3.38	3.10	6.37	4.97	41.99
1861	4.67	2.90	4.97	5.83	5.67	3.68	2.85	5.66	4.61	2.20	4.47	1.17	48.68
1862	5.71	3.01	4.30	1.93	2.93	7.60	5.28	**1.65**	**5.45**	**3.94**	**5.79**	**1.73**	49.32
1863	**4.24**	**5.11**	**4.73**	**4.26**	**1.74**	**1.01**	**11.14**	**4.90**	**1.73**	**3.34**	**5.02**	**5.25**	52.47
1864	**3.07**	**1.40**	**2.06**	**1.82**	**3.82**	**3.00**	**1.68**	**2.92**	**3.45**	**2.66**	**4.13**	**3.99**	34.00
1865	4.92	4.60	6.31	3.26	7.26	4.89	6.84	1.57	1.38	4.33	3.15	4.01	52.52
1866	1.71	6.48	3.41	2.89	5.80	4.31	3.28	4.21	6.17	3.35	4.96	4.38	50.95
1867	2.42	2.64	4.08	2.76	6.31	5.40	2.45	10.53	2.59	5.91	3.50	2.70	51.29
1868	4.55	1.69	2.66	5.58	7.79	3.67	2.44	7.27	8.40	0.93	4.31	2.47	51.76
1869	3.05	5.22	7.02	2.16	6.36	3.23	2.98	1.95	3.27	13.29	3.58	6.35	58.46
1870	6.38	5.19	5.60	6.21	1.39	3.12	2.96	2.11	1.40	5.37	3.43	2.19	45.35

RAINFALL AT WALLINGFORD, CONN. — *Continued.*

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1871	3.88	3.99	6.54	3.84	4.37	6.27	2.03	7.04	2.02	5.55	4.62	3.23	53.38
1872	1.47	2.99	4.16	1.72	3.60	4.23	5.02	6.96	4.31	2.70	5.38	3.66	46.20
1873	6.71	3.52	2.50	3.28	5.42	0.38	2.17	9.93	2.16	5.03	4.36	4.84	50.30
1874	6.51	3.88	1.53	7.88	3.78	1.93	4.54	7.13	3.29	1.20	3.12	2.32	47.11
1875	2.90	5.18	5.48	3.74	2.12	3.37	3.21	4.88	2.10	3.32	5.72	1.37	43.39
1876	1.36	5.26	10.90	4.98	3.61	1.40	10.01	1.69	5.00	1.43	4.37	4.19	54.20
1877	3.47	1.50	8.30	2.35	1.07	6.59	2.35	4.63	0.65	8.34	6.81	1.76	47.82
1878	5.83	5.71	2.95	4.73	3.44	3.97	3.40	3.96	4.87	2.73	5.87	7.06	54.52
1879	2.64	3.88	4.93	5.80	2.32	3.90	8.99	8.04	1.80	1.30	2.00	4.19	49.79
1880	4.02	3.79	3.63	4.59	1.16	2.04	5.38	4.62	3.86	3.89	2.87	3.00	42.85
1881	6.39	6.97	7.79	1.35	4.51	3.54	3.07	1.82	0.68	2.99	4.06	4.89	48.06
1882	5.98	4.59	4.14	1.22	4.51	2.46	2.43	1.51	11.90	3.63	1.62	3.86	47.85
1883	4.81	5.56	2.58	1.91	3.95	2.24	5.05	1.03	2.56	6.51	1.77	4.33	42.30
1884	5.16	6.06	5.40	2.98	3.94	4.52	3.92	5.32	0.91	3.40	2.73	7.53	51.87
1885	5.27	4.17	1.52	2.72	3.07	1.91	3.04	7.96	0.75	5.59	5.05	4.25	45.30
1886	5.37	8.77	3.67	4.20	3.72	2.78	4.23	3.23	2.98	2.73	4.68	5.93	52.29
1887	5.71	7.16	5.05	3.19	0.25	8.12	4.53	4.77	2.12	3.25	2.54	5.18	51.87
1888	7.00	4.30	7.10	1.91	5.27	2.74	2.18	6.18	7.21	6.52	4.42	5.80	60.63
1889	5.17	2.10	3.59	4.99	4.18	4.06	13.58	5.22	5.02	4.45	8.11	2.65	63.12
1890	3.25	3.09	6.43	2.67	4.22	3.34	4.83	3.84	5.66	7.21	0.97	4.18	49.69
1891	9.15	6.73	5.05	3.87	2.34	1.39	5.43	3.01	3.84	4.22	2.87	4.97	52.87
1892	6.41	1.72	3.59	1.14	4.57	1.99	3.47	3.74	2.16	0.92	6.28	1.89	37.88
1893	3.15	8.08	5.86	4.21	8.06	2.35	2.24	4.75	2.42	4.87	2.94	3.82	52.75
1894	2.92	5.45	1.69	3.30	4.56	0.65	1.16	2.23	4.88	7.07	6.86	4.09	44.86
1895	5.59	1.06	3.61	4.07	1.52	6.08	4.50	4.72	2.65	5.83	5.39	3.13	48.15
1896	1.72	8.10	3.93	1.58	2.49	4.30	2.89	3.49	4.12	3.40	2.73	2.41	41.16
1897	4.76	1.95	3.84	2.82	6.64	3.62	16.69	5.13	1.11	1.29	6.86	**5.73**	60.44
1898	**4.56**	**5.27**	**2.72**	**4.98**	**7.87**	**0.27**	4.96	7.93	2.18	7.62	9.48	2.16	60.00
1899	5.02	6.69	8.70	1.97	2.01	2.87	6.67	1.02	3.79	2.49	1.27	1.95	44.45
1900	4.59	8.25	5.24	1.93	4.35	1.61	2.39	1.48	3.54	2.82	5.97	**2.50**	44.67
1901	1.93	0.65	4.36	**10.74**	7.80	1.41	2.33	2.06	5.55	3.84	2.38	8.16	51.21
1902	2.07	6.40	7.39	4.34	1.53	4.44	**3.76**	**2.09**	7.53	6.95	1.64	8.60	56.74
1903	4.01	5.58	6.50	3.13	1.23	11.48	2.46	5.96	1.75	3.33	2.10	4.48	52.01
1904	4.91	4.34	3.54	5.86	2.91	1.33	2.31	5.18	6.05	1.18	2.28	4.33	44.22
1905	5.54	**1.64**	3.29	2.95	1.00	4.56	2.25	5.68	3.86	2.60	2.20	5.03	40.60
1906	4.15	3.15	6.40	3.95	4.58	3.97	4.36	2.52	3.92	6.95	1.95	3.77	49.67
1907	3.23	3.19	1.94	3.95	4.35	**3.41**	1.10	1.09	6.88	3.51	6.18	5.92	44.75
1908	4.46	5.93	3.37	2.39	5.59	1.13	2.84	7.14	0.84	1.70	0.81	**3.90**	40.10
1909	2.93	5.89	4.61	7.13	1.90	2.08	1.52	4.40	4.96	1.32	2.39	4.99	44.12
1910	7.62	4.56	0.72	3.15	3.24	4.88	3.29	3.06	1.81	0.91	4.24	1.92	39.40
1911	3.60	3.95	4.18	3.94	1.13	1.82	2.31	4.75	2.27	6.75	6.64	4.04	45.38
1912	2.58	3.02	9.82	4.45	5.63	0.71	4.22	4.64	1.91	1.20	4.10	5.64	47.92
1913	3.23	3.37	4.99	5.12	2.77	1.47	2.13	3.15	2.37	10.06	2.70	4.72	46.08
Av.	4.36	4.37	4.67	3.71	3.88	3.40	4.10	4.42	3.62	4.04	4.03	4.11	48.71

RAINFALL AT WATERBURY, CONN. Elevation, 400 feet.

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1887	4.75	6.07	4.24	3.84	0.13	6.60	3.79	5.64	1.68	2.97	2.25	5.20	47.16
1888	4.73	5.11	6.46	1.78	4.13	1.55	2.73	4.53	7.57	4.72	4.42	5.84	53.57
1889	5.85	1.61	2.02	4.29	4.61	4.09	10.83	2.76	4.26	4.03	8.74	2.74	55.86
1890	2.54	3.77	6.08	2.43	5.97	3.26	4.96	4.50	4.98	6.89	0.93	5.21	51.52
1891	10.06	5.65	5.08	3.86	1.84	1.14	4.17	3.04	1.68	3.04	3.33	5.71	48.60
1892	6.01	1.30	3.45	0.95	5.55	2.27	4.37	5.30	2.62	0.92	5.96	1.74	40.44
1893	2.96	7.37	4.83	3.46	6.44	1.82	3.31	7.22	1.75	5.21	2.49	4.08	50.94
1894	2.68	4.13	1.43	3.16	7.58	0.54	2.43	2.41	5.35	4.91	4.30	4.21	43.13
1895	4.86	1.92	2.58	3.85	1.96	2.82	3.73	7.29	2.16	5.19	5.22	3.83	45.41
1896	2.37	9.25	5.99	1.83	2.34	5.71	3.16	2.67	5.01	2.77	3.09	2.39	46.58
1897	4.58	3.48	2.67	1.97	5.34	3.77	18.10	3.51	2.18	1.08	6.00	5.99	58.67
1898	5.09	3.49	2.47	3.67	6.86	0.91	3.37	9.48	2.52	5.82	7.57	3.86	55.14
1899	3.82	4.58	6.75	1.80	2.07	2.32	6.02	1.03	5.30	2.42	1.69	2.81	40.61
1900	3.77	8.46	5.51	2.23	4.39	3.02	3.10	2.09	2.15	3.59	5.96	2.56	46.83
1901	1.78	0.55	7.44	11.51	8.08	0.65	4.44	9.37	6.25	4.32	2.37	9.82	66.58
1902	3.43	6.67	5.56	4.11	2.01	5.16	4.58	2.82	6.42	6.19	1.34	6.92	55.21
1903	3.78	4.32	6.45	3.38	0.73	11.25	3.71	6.36	3.02	4.77	2.30	4.37	54.44
1904	4.45	2.54	3.74	4.50	3.31	4.20	4.62	4.93	8.02	3.05	1.59	3.28	48.23
1905	6.50	1.50	3.59	2.85	1.27	4.22	4.20	5.65	4.27	2.50	1.72	3.72	41.99
1906	2.79	2.29	5.97	4.30	3.74	4.83	5.49	2.71	1.92	6.26	2.18	4.13	46.61
1907	3.45	2.52	1.53	2.77	3.87	4.37	2.29	1.35	9.82	5.89	5.69	5.81	49.36
1908	4.72	6.86	3.07	2.65	5.85	1.10	6.53	6.53	1.39	2.43	1.14	3.75	46.02
1909	3.83	6.15	4.36	7.97	2.83	3.11	1.56	3.47	4.51	1.17	1.89	4.83	45.68
1910	8.05	4.27	1.16	4.08	2.95	3.30	3.04	3.16	2.56	0.98	5.40	2.21	41.16
1911	2.99	2.81	3.69	3.75	0.87	3.33	4.54	8.11	2.24	8.27	4.48	3.44	48.52
1912	2.36	3.20	7.87	4.38	5.51	0.91	3.63	3.12	2.34	3.52	3.97	4.64	45.45
1913	3.01	3.02	5.53	5.22	3.76	3.31	1.36	2.93	3.37	8.83	2.92	2.84	46.10
Av.	4.27	4.18	4.43	3.73	3.85	3.32	4.59	4.52	3.90	4.14	3.66	4.29	48.88

NEW YORK.

RAINFALL AT ALBANY, N. Y. Elevation, 97 feet.

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1826	2.43	1.36	3.81	1.77	0.76	6.22	5.53	2.46	3.58	2.37	1.56	1.27	33.12
1827	5.40	3.07	2.38	4.66	3.43	3.75	5.43	4.69	5.67	4.65	2.76	3.91	49.80
1828	2.25	2.53	1.94	2.52	4.48	2.87	5.40	0.88	8.08	1.56	4.91	0.24	37.66
1829	4.56	3.26	2.78	4.77	2.68	3.90	3.22	1.46	2.73	2.41	3.86	2.44	38.07
1830	1.76	1.41	4.86	2.37	4.63	7.58	2.37	1.55	0.93	3.15	7.29	3.95	41.85
1831	1.88	4.17	2.38	4.59	2.88	4.04	4.32	3.25	3.93	4.82	1.71	1.57	39.54
1832	4.21	3.12	2.59	2.90	2.69	3.57	4.28	7.51	2.76	4.20	3.28	3.34	44.45
1833	2.63	2.56	1.62	1.33	8.47	2.36	4.48	3.36	3.14	7.50	2.43	1.86	41.74
1834	1.35	2.04	1.60	2.35	3.70	2.32	5.25	2.77	2.34	3.77	1.37	3.59	32.45
1835	4.64	1.79	2.60	4.54	2.71	6.48	5.39	5.34	1.28	2.22	2.26	1.19	40.44
1836	7.30	4.39	1.70	2.30	3.86	5.67	2.43	2.25	3.49	3.99	3.31	3.91	44.60
1837	2.25	2.77	3.47	1.63	7.34	5.06	4.38	3.96	1.95	3.59	2.14	2.63	41.17
1838	2.25	2.20	2.09	1.53	7.45	7.60	1.72	4.91	4.46	3.32	3.55	0.95	42.03
1839	2.17	1.57	1.52	4.75	3.83	5.12	5.77	1.24	2.75	1.35	2.95	5.09	38.11
1840	2.16	2.44	3.99	5.23	2.28	3.47	3.40	4.77	5.76	4.81	3.13	2.94	44.38
1841	4.19	2.12	3.15	3.75	2.24	2.10	1.56	4.27	5.65	1.34	3.34	4.14	37.85
1842	1.15	3.21	2.69	4.90	1.44	4.14	3.42	4.15	6.40	4.22	4.76	5.21	45.99
1843	2.13	3.21	7.37	4.25	2.07	5.54	4.42	6.05	2.19	5.72	3.04	2.36	48.35

RAINFALL AT ALBANY, N. Y.—*Continued.*

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1844	1.89	1.61	2.82	0.92	5.94	4.60	3.29	2.58	2.23	3.61	2.47	3.04	35.00
1845	3.93	2.94	3.75	2.38	3.92	3.42	2.51	2.42	3.87	2.56	4.42	3.33	39.45
1846	3.03	3.72	3.34	0.74	3.45	3.84	5.58	2.07	2.22	3.53	5.37	2.96	39.85
1847	2.54	3.80	4.39	2.79	2.25	5.06	5.47	1.94	3.56	3.08	2.19	4.31	41.38
1848	2.07	2.37	2.78	1.08	8.11	4.72	7.92	3.79	3.22	4.31	2.61	5.24	48.22
1849	0.76	1.25	2.86	0.75	5.40	4.45	0.70	4.83	1.06	8.04	4.51	2.11	36.72
1850	2.81	2.16	1.96	3.76	6.01	5.72	8.57	2.50	6.56	4.31	2.20	4.41	50.97
1851	0.78	4.38	0.94	4.14	2.61	4.57	3.48	2.17	1.27	2.93	5.10	2.29	34.66
1852	2.16	1.46	3.13	3.85	2.64	1.71	3.36	2.60	1.50	2.38	4.20	2.80	31.79
1853	2.09	3.68	2.35	3.80	7.16	3.48	3.31	5.12	7.67	2.65	3.33	1.15	45.79
1854	2.62	2.95	2.43	6.82	1.79	2.96	3.35	0.62	3.87	1.85	3.00	1.84	34.10
1855	3.29	1.09	0.54	2.65	1.83	6.84	3.95	3.75	2.52	8.93	3.27	3.82	42.48
1856	1.10	0.36	1.83	1.48	5.94	3.62	1.33	10.14	4.89	2.35	2.56	3.50	39.10
1857	2.08	2.18	1.25	7.00	4.45	4.91	5.45	3.74	1.53	4.31	1.92	3.04	41.86
1858	2.32	1.15	1.99	2.42	3.49	3.31	6.94	2.90	2.44	1.76	3.02	2.32	34.06
1859	1.90	1.94	1.79	2.72	1.74	5.21	3.17	3.19	4.72	1.30	2.19	2.14	32.01
1860	0.08	1.50	0.60	1.18	1.68	3.48	4.55	6.09	5.17	2.32	3.43	2.17	32.25
1861	3.49	2.28	4.11	0.86	3.50	1.46	6.04	4.15	3.14	3.23	2.29	1.50	36.05
1862	5.24	2.06	3.05	1.96	1.16	8.70	3.62	2.84	1.08	3.62	3.16	1.33	37.82
1863	4.81	2.62	3.65	1.48	4.76	1.37	7.83	3.60	1.76	2.57	5.12	3.64	43.21
1864	1.49	0.75	2.21	2.71	2.57	0.80	1.48	4.91	2.14	2.55	2.88	3.45	27.94
1865	2.46	1.94	4.48	2.48	5.39	3.04	3.70	1.08	2.78	4.33	2.72	2.04	36.44
1866	1.11	2.49	1.32	1.46	2.17	4.51	4.18	2.73	5.65	1.87	3.22	3.56	34.27
1867	1.55	2.48	2.43	2.68	6.28	4.57	3.18	7.28	1.56	3.69	1.31	1.03	38.04
1868	3.15	0.68	1.82	4.01	7.03	3.64	1.61	3.62	7.11	1.91	5.45	1.85	41.88
1869	3.28	3.23	2.49	2.19	4.57	1.39	2.89	2.89	3.35	13.48	1.56	2.88	44.20
1870	5.38	5.19	3.84	2.70	1.78	7.48	7.19	8.47	5.02	4.05	3.06	1.65	55.81
1871	2.30	2.00	7.29	3.79	4.97	7.25	9.37	10.59	0.85	3.34	3.38	1.65	56.78
1872	0.78	1.74	2.70	1.81	4.79	4.68	5.60	4.84	2.55	4.68	2.77	2.18	39.12
1873	3.32	2.11	3.65	1.99	1.98	0.99	5.97	2.27	4.78	5.57	3.75	3.03	39.41
1874	3.61	2.90	1.97	4.97	2.32	4.71	6.78	1.94	4.01	1.77	2.19	0.76	37.93
1875	2.14	1.65	3.27	3.63	2.57	3.98	2.46	6.55	2.63	5.97	2.29	1.11	38.25
1876	1.57	4.09	4.28	3.51	2.96	4.40	4.97	0.53	5.17	1.64	2.65	2.42	38.19
1877	1.95	0.36	3.33	1.42	2.77	4.60	4.00	4.57	1.82	7.86	2.70	0.71	36.09
1878	4.45	4.12	2.18	3.99	3.65	4.54	5.52	3.76	3.20	3.37	4.43	6.16	49.37
1879	2.54	2.80	3.79	3.17	0.89	4.62	5.10	4.25	3.47	1.24	2.56	4.23	38.66
1880	2.96	2.67	2.17	2.75	3.35	2.21	3.78	2.84	2.86	2.45	2.49	2.01	32.54
1881	2.86	2.50	3.80	1.34	3.90	3.76	2.22	2.07	2.38	3.19	3.44	4.88	36.34
1882	2.64	3.31	1.79	1.27	4.15	3.98	3.97	1.38	7.79	0.27	0.97	2.24	33.76
1883	2.43	3.00	1.77	2.65	3.20	6.30	5.96	3.69	3.19	3.49	1.14	2.55	39.37
1884	2.98	3.85	4.00	2.09	2.79	1.80	5.04	5.27	1.80	2.64	3.44	3.20	38.90
1885	3.09	1.38	0.62	2.89	1.92	1.98	1.98	7.58	2.00	5.54	3.90	1.50	34.38
1886	3.66	1.40	2.73	3.67	3.40	3.19	2.56	0.87	2.51	2.43	5.40	2.19	34.01
1887	3.02	2.86	2.90	2.49	2.27	2.99	4.61	4.61	1.94	2.22	4.36	5.43	39.70
1888	3.04	2.07	5.62	1.95	2.98	3.18	2.52	4.74	4.68	6.10	4.48	3.30	44.66
1889	2.82	1.81	1.76	1.25	3.32	6.43	4.19	3.63	3.68	3.48	5.00	2.14	39.51
1890	2.28	2.52	3.72	1.64	5.19	2.72	2.37	5.66	8.91	5.76	1.18	2.94	44.89
1891	6.12	4.11	3.12	2.27	1.69	2.65	6.11	5.88	1.94	2.13	2.40	3.23	41.68
1892	4.08	2.13	1.64	0.56	5.30	4.41	4.22	6.70	2.08	0.60	2.29	0.82	34.83
1893	1.31	4.63	2.00	2.10	5.08	2.92	1.82	7.21	3.20	1.67	0.91	2.54	35.39

RAINFALL AT ALBANY, N. Y. — *Continued.*

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1894	2.54	2.61	0.85	2.02	4.64	3.29	2.96	2.24	4.18	4.62	1.96	3.18	35.09
1895	1.65	1.63	1.31	3.09	1.72	1.72	4.02	3.14	1.80	2.35	4.78	2.59	29.80
1896	0.98	4.03	4.66	0.98	1.55	2.49	3.57	2.25	3.31	1.53	1.80	0.73	27.88
1897	1.62	2.05	1.85	1.24	4.69	4.45	6.67	4.43	1.50	1.01	4.65	4.38	38.54
1898	2.96	3.57	1.08	2.63	4.07	5.58	1.07	6.67	1.61	4.29	4.22	1.02	38.77
1899	2.50	2.92	3.97	1.03	2.23	1.61	2.69	1.77	6.33	0.85	1.47	1.55	28.92
1900	2.33	2.84	4.62	1.31	1.36	3.54	3.41	2.83	0.74	1.83	3.95	1.80	30.56
1901	1.59	0.56	4.14	4.66	4.79	3.14	4.26	4.51	2.96	2.48	2.02	5.42	40.53
1902	0.67	3.04	3.24	2.33	1.91	3.91	5.37	3.98	4.15	2.80	0.95	5.13	37.48
1903	1.83	2.05	3.55	0.79	0.15	6.44	3.51	5.14	1.30	6.09	1.65	1.59	34.09
1904	2.51	1.17	1.94	2.87	2.16	5.48	2.96	2.78	3.88	3.09	0.64	1.78	31.26
1905	2.66	0.80	2.43	2.12	0.96	3.58	2.00	3.83	3.37	2.38	1.49	1.36	26.98
1906	0.97	2.09	2.54	2.20	3.90	5.80	3.91	2.49	1.57	2.62	2.46	1.96	32.51
1907	1.71	1.15	0.87	2.33	3.21	3.29	4.14	0.74	5.81	3.71	4.15	2.52	33.63
1908	1.36	2.77	1.43	2.62	4.26	2.32	5.33	3.63	0.64	2.07	0.40	1.58	28.41
1909	3.00	4.00	2.11	2.12	2.72	2.74	1.74	2.54	2.88	0.83	1.04	2.36	28.08
1910	4.13	3.29	0.52	4.19	3.49	2.40	1.28	1.38	3.21	0.87	2.74	1.01	28.51
1911	1.56	1.02	2.51	1.15	2.15	4.27	3.16	4.53	2.86	5.00	1.51	2.38	32.10
1912	1.10	1.56	3.71	3.31	4.48	0.98	3.13	3.00	3.01	3.37	2.08	2.39	32.12
1913	2.20	1.64	4.22	1.38	3.29	1.71	1.82	1.14	1.79	4.12	1.48	1.60	26.39
Av.	2.59	2.44	2.75	2.64	3.50	3.95	4.04	3.77	3.33	3.41	2.93	2.63	37.98

RAINFALL AT COOPERSTOWN, N. Y. Elevation, 1,250 feet.

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1854	2.10	3.46	3.33	7.12	3.11	2.85	2.25	1.43	4.13	3.11	2.71	2.30	37.90
1855	3.34	1.23	0.61	4.15	2.20	9.76	4.84	6.78	2.24	5.28	3.56	4.13	48.12
1856	1.12	0.60	1.54	3.42	4.44	2.19	2.82	9.46	3.45	0.88	2.00	2.65	34.57
1857	2.36	2.15	1.83	5.53	5.63	7.80	5.20	6.79	2.45	6.65	2.29	3.32	52.00
1858	1.77	1.66	0.97	2.66	4.65	8.08	7.11	3.43	2.43	4.46	5.38	2.82	45.42
1859	2.53	0.94	3.95	4.19	1.92	5.39	4.47	4.65	5.41	1.66	3.18	3.02	41.31
1860	0.32	0.71	1.05	1.55	1.83	3.15	6.89	7.07	2.69	2.80	4.22	1.45	33.73
1861	2.00	1.30	2.71	3.92	3.14	1.97	7.36	4.64	3.57	5.16	3.13	1.78	40.68
1862	3.66	1.73	3.80	1.90	1.40	6.13	3.37	3.28	2.39	4.80	4.17	1.34	37.97
1863	4.04	2.32	2.92	0.92	6.28	3.43	7.92	5.86	4.33	1.74	3.59	3.94	47.29
1864	1.68	0.85	2.29	2.19	3.40	1.00	1.79	5.81	2.86	2.39	2.37	3.27	29.90
1865	2.23	1.60	3.45	2.19	4.92	2.39	3.70	1.02	4.86	3.80	3.34	1.94	35.44
1866	0.97	3.45	1.70	1.02	2.00	4.27	3.57	2.24	5.04	1.32	4.25	2.50	32.33
1867	0.85	3.45	1.70	3.54	7.38	2.15	3.35	5.40	3.36	3.68	1.52	1.63	38.01
1868	2.24	0.93	2.74	2.43	5.76	4.94	0.89	2.47	5.74	2.10	5.28	1.91	37.43
1869	4.31	2.67	2.88	3.68	5.49	4.31	4.57	3.02	3.31	6.10	1.91	3.69	45.94
1870	4.17	3.72	2.53	2.36	1.94	0.95	4.14	2.74	2.76	3.80	1.92	1.96	32.99
1871	1.14	1.94	5.29	2.66	3.18	5.24	4.64	4.50	1.17	1.97	2.68	1.76	36.17
1872	0.52	1.58	0.80	1.17	4.16	7.31	5.84	4.45	3.32	3.62	1.98	2.17	36.92
1873	3.01	1.67	4.00	3.09	1.65	1.94	5.26	5.52	3.41	5.62	4.16	2.86	42.19
1874	3.70	3.30	1.35	4.10	1.68	7.00	5.34	1.06	2.25	2.60	2.85	1.27	36.50
1875	2.16	1.19	3.19	2.55	2.36	5.24	3.24	5.85	2.52	4.96	3.00	1.48	37.74
1876	2.11	4.13	3.36	1.68	1.97	4.93	5.13	0.63	5.79	1.73	1.45	2.26	35.17
1877	2.58	0.63	3.37	1.77	1.27	4.71	6.78	2.84	1.92	4.42	3.22	0.97	34.48
1878	3.33	1.80	2.87	2.47	4.20	4.25	3.57	2.93	3.29	3.29	3.18	3.80	38.98

RAINFALL AT COOPERSTOWN, N. Y.—*Continued.*

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1879	2.35	2.91	2.01	3.48	0.36	4.16	2.85	1.43	2.12	1.26	3.00	4.26	30.19
1880	4.26	2.26	1.71	2.76	3.32	2.78	4.49	2.78	3.17	2.42	3.02	1.23	34.20
1881	2.54	1.53	3.05	0.98	3.00	3.59	3.07	0.72	1.43	4.89	3.24	6.02	34.06
1882	2.67	3.17	2.48	1.30	3.98	4.88	2.44	0.91	3.68	1.48	1.79	2.02	30.80
1883	1.49	3.74	1.69	1.68	3.15	4.62	4.77	3.21	5.05	2.96	1.76	1.93	36.05
1884	3.17	3.16	4.48	1.20	3.97	2.16	3.01	2.46	1.29	3.31	2.86	4.00	35.07
1885	3.00	2.46	0.55	1.94	3.39	3.59	3.00	9.08	1.96	4.19	3.05	2.15	38.36
1886	1.83	1.86	2.92	1.86	2.50	3.01	3.02	2.56	4.12	2.54	4.72	2.00	32.94
1887	3.23	5.21	4.32	2.42	2.83	2.56	2.85	3.34	1.42	1.19	3 15	3.43	35.95
1888	2.47	1.58	3.34	3.05	2.76	4.32	1.52	4.95	3.97	4.09	3.09	3.30	38.44
1889	2.22	1.79	1.76	2.93	3.96	5.95	5.61	2.13	3.87	2.17	3.50	2.68	38.57
1890	4.39	2.91	4.17	2.86	8.84	4.89	3.39	6.01	7.24	5.91	3.17	4.33	58.11
1891	5.54	4.76	2.60	2.22	2.16	1.98	5.02	4.26	1.41	3.01	3.15	4.96	41.07
1892	4.99	2.23	3.43	1.38	7.82	4.86	7.80	7.96	3.57	1.79	3.19	1.53	50.55
1893	1.89	4.99	2.13	2.96	6.74	2.20	4.85	7.59	4.03	1.27	2.20	4.02	44.87
1894	2.84	2.00	1.92	2.54	5.29	2.62	3.41	1.88	5.55	4.73	2.72	2.33	37.83
1895	2.34	1.43	1.93	2.89	2.44	2.18	3.80	7.15	2.86	2.17	3.65	3.89	36.73
1896	1.48	5.36	4.74	1.25	2.33	4.70	4.60	3.49	4.33	2.23	3.56	1.21	39.28
1897	1 72	2.06	3.31	3.65	5.21	5.22	4.86	6.60	3.40	0.64	5.21	4.64	46.52
1898	4.90	2.93	2.14	4.00	4.70	3.80	3.02	9.75	4.20	5.36	4.64	2.44	51.88
1899	2.22	2.31	6.04	1.87	4.52	2.85	3.92	2.72	3.17	2.25	1.93	4.10	37.90
1900	3.08	5.59	2.91	1.94	1.98	3.03	6.61	4.62	1.92	2.57	4.62	2.59	41.46
1901	2.47	1.12	3.00	4.73	4.94	3.65	6.79	5.96	3.08	2.48	2.74	4.85	45.81
1902	1.04	2.89	3.70	3.10	2.76	5.43	9.17	3.05	4.39	4.00	1.48	4.30	45.31
1903	3.30	3.61	5.84	1.57	0.17	7.35	5.52	7.26	1.64	8.32	2.21	2.66	49.45
1904	4.29	3.00	3.06	2.84	2.40	4.00	4.74	4.55	4.08	3.49	1.18	2.49	40.12
1905	3.11	2.04	2.48	3.09	3.35	6.58	6.31	4.91	4.54	3.49	2.71	3.15	45.76
1906	2.34	2.55	4.62	2.83	7.35	6.47	3.44	6.48	2.28	3.63	3.01	3.85	48.85
1907	3.04	1.30	1.87	4.67	2.62	3.92	6.33	1.70	8.07	4.86	4.01	4.19	46.58
1908	2.31	4.32	2.72	3.98	5.50	2.27	5.50	2.77	1.63	3.29	1.22	3.34	38.85
1909	4.14	5.66	2.91	3.29	4.96	3.74	5.65	3.87	2.98	2.56	1.90	2.56	44.22
1910	5.23	6.68	1.23	4.27	5.05	4.24	2.04	2.34	6.82	1.32	2.73	1.88	43.83
1911	2.88	2.50	3.15	1.47	2.77	5.74	3.03	7.39	4.06	4.95	3.33	2.92	44 19
1912	1.93	2.71	4.41	3.81	2.99	1.44	3.93	6.09	7.85	4.93	3.98	3.05	47.12
1913	4.46	2.14	3.60	1.65	4.11	2.55	2.31	2.86	2.73	5.12	3.69	2.37	37.59
Av.	2.72	2.60	2.84	2.74	3.67	4.14	4.45	4.31	3.54	3.38	3.05	2.85	40.29

RAINFALL AT CORTLAND, N. Y. Elevation, 1,129 feet.

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1851	1.30	5.77	1.94	4.22	5.41	4.94	5.51	2.67	2.09	2 16	2.60	3.01	41.62
1852	2.08	1.89	3.38	3.67	4.71	3.78	7.52	3.40	3.09	4.30	4.56	3.98	46.36
1853	2.57	4.49	2.90	4.41	4.69	3.94	2.28	3.59	4.72	4.56	3.15	1.76	43.06
1854	2.60	4.46	3.34	5.84	2.33	3.31	2.19	2.19	3.91	3.73	3.07	3.13	40.10
1855	4.23	2.20	1.43	5.35	4.01	8.69	6.27	2.80	2.67	4.11	3.39	3.91	49.06
1856	2.07	1.02	1.99	2.85	4.06	3.41	3.85	3.65	4.17	2.08	2.98	2.30	34.43
1857	3.02	2.05	2.58	6.78	4.38	12.55	2.39	5.40	4.45	4.88	3.48	3.29	55.25
1858	2.35	2.22	1.17	2.70	5.01	3.28	5.09	3.69	3.62	3.33	3.93	4.93	41.32
1859	2.94	1.82	4.71	5.54	3.85	5.54	5.07	5.49	5.12	1.65	3.77	4.06	49.56
1860	1.38	1.04	4.01	2.70	3.53	5.56	6 43	4 66	4.13	3.46	3.75	2.42	43.07

RAINFALL AT CORTLAND, N. Y. — *Continued.*

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1861	2.86	3.30	3.01	4.99	5.02	5.88	1.79	5.36	6.56	5.47	2.32	1.95	48.51
1862	4.01	2.92	4.92	1.78	1.79	4.64	7.00	2.58	1.52	6.73	3.34	2.81	44.04
1863	...	...	...	...	...	...	...	...	...	...	...	...	...
....	...	...	...	...	...	...	...	...	...	...	...	...	...
....	...	...	...	...	...	...	...	...	...	...	...	...	...
1893	1.54	2.90	2.22	3.12	6.29	1.45	4.75	4.37	4.17	3.73	1.94	2.35	38.83
1894	2.75	2.01	1.59	2.75	6.31	4.60	2.53	1.45	4.44	4.39	1.98	1.70	36.50
1895	2.95	0.97	1.36	1.62	2.60	2.91	5.55	5.55	2.36	0.85	3.05	3.86	33.63
1896	1.86	4.50	4.54	0.93	2.73	3.44	4.36	2.15	3.70	3.32	3.17	2.32	37.02
1897	2.68	1.11	1.55	0.68	4.33	3.81	4.46	2.07	3.13	0.71	3.55	3.00	31.08
1898	4.74	2.39	2.07	3.43	4.96	2.80	3.14	9.44	3.46	6.27	3.10	2.61	48.41
1899	1.88	0.69	1.83	0.56	2.50	2.25	4.69	2.64	2.40	2.99	2.99	3.98	29.40
1900	3.28	1.84	1.49	1.56	1.17	2.40	4.78	1.92	2.00	4.59	7.17	2.54	34.74
1901	1.22	1.44	2.76	3.21	3.25	2.96	3.49	3.83	2.90	1.02	3.47	6.41	35.96
1902	1.25	1.35	3.20	1.21	2.79	5.03	10.12	3.68	2.51	3.59	1.07	4.78	40.58
1903	1.70	1.71	5.13	1.12	0.30	6.12	3.99	8.21	2.07	11.47	2.24	1.62	45.68
1904	3.62	2.10	2.85	3.50	4.03	2.57	7.55	4.50	5.02	3.29	0.84	2.68	42.55
1905	3.26	0.96	3.28	2.63	2.26	5.82	2.85	4.34	3.09	4.28	2.36	3.56	38.69
1906	1.57	1.06	2.98	1.67	5.73	2.92	5.58	4.18	2.20	3.97	2.25	3.99	38.10
1907	3.50	2.21	1.26	2.49	3.39	1.48	5.64	0.37	4.41	4.53	2.86	3.03	35.17
1908	1.67	3.14	2.66	2.59	5.49	3.57	3.87	1.39	1.02	2.33	1.47	1.80	31.00
1909	2.91	4.04	2.40	3.17	2.39	3.14	2.62	2.15	3.45	2.96	1.54	1.61	32.38
1910	3.55	3.36	0.60	2.52	4.14	1.62	2.27	1.59	4.99	1.79	3.26	2.39	32.08
1911	2.42	2.93	2.10	1.62	2.20	3.79	3.00	3.69	3.26	4.11	2.56	2.85	34.53
1912	1.92	2.19	2.78	3.49	3.38	1.72	2.97	5.31	5.66	2.06	3.57	2.22	37.27
1913	4.47	1.91	4.61	1.60	3.58	2.21	1.72	2.13	2.35	3.43	3.06	2.59	33.66
Av.	2.61	2.36	2.69	2.92	3.72	4.00	4.40	3.65	3.47	3.70	2.97	3.01	39.50

RAINFALL AT BOYD'S CORNER RESERVOIR, (CROTON WATERSHED), N. Y.
Elevation 600 feet.

(New York Water Supply.)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1868	2.90	1.38	2.55	3.87	8.79	4.53	2.13	6.98	9.33	0.87	4.65	2.35	50.33
1869	3.79	3.64	5.48	2.11	4.52	3.59	2.26	1.92	3.20	9.46	2.43	5.96	48.36
1870	4.51	6.40	3.80	5.45	2.30	2.06	3.43	5.10	2.85	4.73	2.51	1.49	44.63
1871	3.80	3.81	4.27	3.01	3.45	5.73	5.07	5.24	1.44	6.18	4.35	2.59	48.94
1872	1.44	1.22	2.59	3.04	3.69	4.00	4.34	5.99	3.69	2.15	4.91	3.68	40.74
1873	5.66	3.09	3.08	3.77	2.91	0.71	2.21	5.73	3.73	5.13	3.72	4.13	43.87
1874	6.96	2.78	1.57	6.31	1.99	3.57	5.98	2.75	3.56	2.40	2.72	1.78	42.37
1875	2.74	3.47	4.99	3.04	1.08	3.02	3.10	10.33	2.11	3.61	4.61	1.56	43.66
1876	1.42	4.91	6.33	4.43	3.99	2.52	3.42	1.20	5.21	1.50	3.40	2.35	40.68
1877	2.68	0.80	7.66	2.35	0.85	4.95	4.65	2.54	1.49	8.38	8.16	1.52	46.03
1878	4.49	3.65	3.10	2.85	4.97	4.65	4.28	2.66	6.61	3.78	4.36	8.74	54.14
1879	2.52	2.85	4.96	5.10	2.45	5.53	5.95	5.83	3.43	0.95	3.47	4.26	47.30
1880	3.73	3.32	3.79	3.99	1.07	1.25	5.79	3.60	2.69	3.25	2.97	2.49	37.94
1881	4.19	5.28	6.14	1.67	5.11	4.35	2.66	1.66	0.75	3.75	4.50	6.02	46.08
1882	4.49	5.97	4.92	1.42	6.30	3.04	3.66	3.92	14.41	3.36	1.66	2.68	55.83
1883	2.98	5.21	1.87	3.91	2.86	5.63	4.29	2.10	2.52	7.03	1.72	3.45	43.57
1884	5.15	6.23	4.82	2.96	4.33	1.95	6.86	5.38	0.96	3.65	4.37	7.34	54.00
1885	5.59	4.66	1.26	2.09	2.44	1.19	5.26	7.35	1.09	5.13	5.99	3.78	45.83

RAINFALL AT BOYD'S CORNER RESERVOIR (CROTON WATERSHED), N. Y.

Continued.

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1886	5.99	4.87	3.86	3.52	4.54	3.39	4.76	3.21	2.30	2.28	5.57	4.29	48.58
1887	5.68	5.95	3.60	3.47	0.32	7.70	13.55	6.85	1.90	3.12	2.69	6.71	61.54
1888	5.56	5.07	6.44	2.68	6.17	2.19	2.24	6.87	10.77	4.80	4.49	6.13	63.41
1889	5.14	2.33	1.86	4.42	3.22	4.76	7.49	2.90	6.13	5.09	8.01	2.94	54.29
1890	1.97	4.94	5.66	3.03	5.74	3.56	5.46	4.70	6.86	7.63	1.12	3.69	54.36
1891	9.76	6.00	3.36	3.77	1.36	1.81	3.03	5.61	1.87	2.21	3.86	5.65	48.29
1892	5.95	1.22	3.92	1.08	5.74	3.84	5.05	6.13	2.65	0.92	7.85	1.15	45.50
1893	4.03	8.05	4.52	3.55	8.81	2.44	2.38	7.06	2.65	6.42	3.32	5.34	58 57
1894	3.40	4.99	1.62	3.11	6.90	1.59	1.75	1.45	7.69	5.99	4.12	4.43	47.04
1895	4.85	1.85	1.88	5.63	2.29	1.94	3.80	3.10	1.06	3.55	2.98	4.85	37.78
1896	1.09	8.41	8.30	1.48	3.48	3.47	3.98	4.60	6.54	2.21	3.96	2.72	50 24
1897	4.07	3.14	3.68	2.78	5.56	3.41	12.51	5.63	1.74	2.01	6.31	6.56	57.40
1898	5.89	5 21	2.64	3.74	7.37	1.50	4.78	7.66	2.17	4.84	6.81	3.17	55.78
1899	3.37	5.54	7.56	1.99	1.80	5.38	5.99	0.48	8.86	1.48	2.05	2.75	47.25
1900	4.18	7.97	5.03	2.21	6 40	2.19	4.28	1.75	3 27	4 73	4.91	2.58	49.50
1901	1.69	0.94	7.54	8.48	7.91	1.46	7.08	8.21	4.72	3.26	1.99	9.53	62.81
1902	2.77	4 67	7.49	4 57	3.31	4.68	3.77	2.91	6.07	5.95	0 91	7.39	54.49
1903	4.52	5.73	6.30	2.68	1.25	11.81	3.54	9.08	2.61	8.59	2.48	4.67	63.26
1904	4.52	3.22	3.77	4.23	4.99	2.40	6.73	5.16	7.21	4.00	1.78	3.48	51.49
1905	6.54	1.76	3.98	2.74	1.05	4.87	3.73	5.09	5 62	3 25	2.63	4.04	45.30
1906	2.55	2.64	7.05	5.33	4.32	4.14	8.03	3.06	1.94	4.39	1.38	3.84	48.67
1907	4.10	2.61	2.06	4.29	4.35	5.64	1.64	1.96	9.77	8.49	5.87	5.66	56.44
1908	3.97	6.27	3.53	3.23	6.20	2.22	2.50	4.59	1.04	2.09	0.90	3.57	40.11
1909	4.78	6.04	4.57	6.77	2.39	3.85	3.17	7.55	4.31	1.23	2.83	4.06	51.55
1910	7.42	5.13	0.64	5.59	3.41	4.38	2.46	3.03	2.37	0 99	3.97	2.97	42.36
1911	2.83	2.83	4 69	3.76	3 17	3.56	2.60	9.71	4.19	7.69	4.19	3.67	52 89
1912	2 05	3.15	7.64	4.85	6.38	1.29	2.97	4.92	3.12	4 85	4.61	4.46	50.29
1913	4 14	2.29	8.30	5.50	3.11	0 93	2.21	4 17	4 99	9.61	2.87	3.05	51 17
Av.	4.17	4.16	4.45	3.69	4.01	3.54	4.50	4.52	4.21	4.50	3.80	4.12	49.67

RAINFALL AT MIDDLE BRANCH RESERVOIR (CROTON WATERSHED), N. Y.

Elevation, 400 feet.

(New York Water Supply.)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1878	5.03	3.56	3.07	3.18	4.72	4.33	3.98	4.55	8.56	3.51	4.46	6.94	55 89
1879	2.24	2.57	3.86	4.80	2.02	5.29	6.12	6.69	3.42	0.57	2.63	4.06	44.27
1880	3.44	3.47	3.70	3.44	1.00	1.46	5.62	4.05	2.16	2.56	1.85	2.44	35.19
1881	5.06	4.65	5.50	1.20	3.89	4.62	2.63	2.82	0.94	2.94	5.53	5.92	45.70
1882	4.69	5 94	3.75	1.31	5.51	2.33	2.77	2.35	13.43	2.79	1.49	2.15	48.51
1883	2.88	4.79	1.56	2.89	2.39	3.50	4.22	3.08	2.80	6.06	1.73	3.32	39.22
1884	4.78	5.27	3.77	2.73	3.70	2.54	6.43	7.36	0.95	3.23	3.86	5.93	50.55
1885	5.02	4.44	1.14	2.12	1.85	1.18	4.95	6.52	1.19	4.70	5.76	2.41	41.28
1886	5.23	4.22	3.86	3.65	4.59	3.08	5.68	2.92	2.69	1.95	5.29	4.02	47.18
1887	5.65	6.30	3.73	2.90	0.30	6.25	11.12	7.56	1.81	3.79	2.61	5.09	57.11
1888	5.24	5.15	6.69	2.53	5.77	1.97	2.40	6.58	10.05	4.89	4.20	5.89	61.36
1889	4.84	2.22	1.54	4.23	3.17	3.67	11.71	3.43	7.14	3.35	8.73	3.25	57.28
1890	2.73	4.55	6.01	3.72	5.92	4.63	5.08	3.91	7.32	6.49	1.09	4.41	55.86
1891	8.88	6.00	3.42	2.76	1.49	2.30	4.57	5.31	2.00	2.47	3.36	5.51	48.07
1892	6 43	1 07	3 71	1 04	5 84	3 19	6 06	5 93	2 04	0 94	6 93	1 06	44.24

RAINFALL AT MIDDLE BRANCH RESERVOIR (CROTON WATERSHED), N. Y.
Continued.

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1893	3.21	7.86	4.37	3.02	7.90	2.08	2.56	7.35	2.24	5.32	3.25	5.11	54.27
1894	3.33	4.54	2.02	2.84	5.49	1.51	3.46	5.80	6.16	5.97	4.67	4.30	50.09
1895	4.91	2.10	2.35	4.42	2.41	2.82	4.48	4.72	0.78	3.74	5.06	4.12	41.91
1896	1.30	7.18	6.80	1.13	2.93	4.00	4.28	3.74	5.17	2.39	3.38	1.93	44.23
1897	3.53	2.66	3.49	3.05	6.03	3.18	11.15	5.21	1.79	0.93	5.72	4.78	51.52
1898	4.60	4.18	2.89	3.50	7.89	1.39	3.52	13.94	2.23	4.63	6.34	3.17	58.28
1899	3.78	5.84	6.46	1.58	2.10	5.52	6.17	0.32	7.10	1.29	1.82	2.37	44.35
1900	3.73	7.77	4.52	1.87	6.45	2.15	3.88	3.18	3.52	4.50	5.98	2.47	50.02
1901	1.78	0.79	6.94	7.61	6.78	2.09	8.80	7.98	5.88	5.21	1.65	8.69	64.20
1902	3.12	3.60	7.01	4.68	3.30	5.33	4.37	3.23	6.73	6.55	1.25	7.34	56.51
1903	4.63	4.96	5.19	2.69	1.16	11.35	2.45	6.88	2.67	6.90	2.89	3.68	55.45
1904	3.73	3.10	3.83	4.03	4.45	2.25	5.32	6.43	4.64	3.63	1.89	3.37	46.67
1905	6.53	1.84	4.27	3.22	1.08	6.78	2.62	5.43	3.51	3.14	2.33	3.57	44.32
1906	2.44	2.93	6.36	4.11	3.95	4.87	5.34	2.74	3.02	4.99	1.58	4.21	46.54
1907	4.70	2.50	2.59	4.04	5.61	4.71	2.14	3.09	10.58	8.97	5.57	5.61	60.11
1908	4.21	5.63	4.08	3.30	6.13	2.26	3.03	6.12	0.83	1.92	1.09	3.32	41.92
1909	4.80	6.50	4.39	7.63	2.71	2.95	2.83	6.61	4.41	1.17	3.54	4.01	51.55
1910	8.09	5.88	0.77	4.04	4.19	4.54	3.24	3.55	2.16	1.20	5.07	2.61	45.34
1911	3.50	2.97	4.44	3.96	3.21	3.43	2.48	9.13	2.72	7.61	4.60	3.67	51.72
1912	1.88	2.66	7.31	3.74	4.92	1.10	3.48	3.98	3.49	3.86	3.82	4.29	44.53
1913	3.56	2.58	5.50	4.91	3.42	1.04	2.23	4.17	4.40	9.76	2.82	2.50	46.89
Av.	4.26	4.23	4.19	3.39	4.01	3.49	4.75	5.18	4.18	4.00	3.72	4.10	49.50

RAINFALL AT OLD CROTON DAM, NEW YORK. Elevation, 200 feet.
(New York Water Supply.)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1868	3.23	1.52	3.91	5.47	13.78	7.11	3.65	13.05	20.47	0.63	7.14	2.50	82.46
1869	5.40	5.75	9.51	3.38	6.72	1.19	2.06	1.97	2.64	8.93	7.23	5.74	60.52
1870	3.70	6.37	7.23	4.95	2.71	3.50	2.75	7.71	2.36	7.62	3.74	1.20	53.84
1871	3.80	3.81	4.27	3.01	3.45	5.73	5.07	5.24	1.44	6.18	4.35	2.59	48.94
1872	0.76	1.29	3.57	0.70	3.93	3.65	5.11	7.83	3.17	1.80	4.51	1.80	38.12
1873	2.96	1.40	1.90	3.17	3.02	0.14	4.41	9.91	5.36	4.85	2.16	2.37	41.68
1874	5.98	0.17	0.54	3.49	1.59	2.26	5.96	4.22	4.32	1.90	2.68	0.99	34.10
1875	2.01	3.83	5.87	3.78	1.36	2.78	7.34	13.06	1.76	4.27	6.00	1.86	53.92
1876	1.68	7.92	14.64	3.82	3.87	4.34	6.03	2.51	4.37	2.13	3.39	6.50	61.20
1877	3.22	1.21	8.98	2.72	0.57	5.58	6.48	3.18	1.09	10.69	7.54	1.35	52.61
1878	4.30	5.90	2.87	3.00	4.11	3.13	3.86	2.63	15.86	6.07	6.27	13.28	71.28
1879	4.56	4.98	5.76	4.17	2.74	4.81	5.15	9.29	2.88	0.60	2.99	5.64	53.57
1880	2.96	3.33	4.59	3.28	1.10	1.47	6.56	5.25	2.64	2.86	2.54	3.16	39.74
1881	5.32	6.70	9.73	0.86	2.74	5.27	1.82	2.75	0.41	1.76	5.60	7.54	50.50
1882	8.92	5.27	3.71	1.46	6.44	2.57	3.19	3.82	16.26	2.77	1.71	3.17	59.29
1883	5.27	7.11	2.22	3.94	2.45	3.83	5.80	2.55	2.47	5.53	1.13	4.84	47.14
1884	9.01	8.37	3.31	3.15	3.92	3.30	5.56	8.87	0.34	1.32	5.23	6.58	58.96
1885	6.18	9.19	1.62	2.51	1.87	0.99	4.87	7.33	0.87	5.96	6.43	3.38	51.20
1886	7.79	6.52	4.48	5.09	4.02	3.35	4.46	3.58	1.43	2.51	5.13	3.19	51.55
1887	6.44	7.08	3.59	3.02	0.18	6.80	10.72	4.37	1.47	3.77	2.17	4.99	54.60
1888	4.91	4.63	3.32	2.46	6.73	2.76	2.80	6.49	8.19	4.47	3.33	5.59	55.68
1889	5.15	2.40	1.79	5.48	2.21	3.18	8.39	5.21	5.67	3.39	8.41	2.92	54.23
1890	2.51	3.30	7.19	3.71	5.57	3.75	4.70	4.41	4.58	6.29	0.81	2.78	49.60

RAINFALL AT OLD CROTON DAM, NEW YORK.—*Continued.*

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1891	8.11	4.58	3.53	2.66	2.30	2.42	4.59	4.21	2.31	2.24	3.31	4.99	45.25
1892	5.96	1.28	2.92	1.28	4.99	4.28	4.92	5.19	2.18	0.77	6.46	1.16	41.39
1893	3.93	5.78	3.85	2.99	6.31	2.94	3.97	7.36	3.09	4.54	2.99	4.56	52.31
1894	2.48	4.23	1.34	2.23	4.73	2.20	1.73	3.01	6.96	4.33	5.21	3.77	42.22
1895	3.74	1.67	2.00	3.97	1.60	2.05	6.11	3.55	3.16	3.58	4.84	4.72	40.99
1896	0.89	5.94	9.78	1.05	3.02	4.65	6.50	2.81	4.89	1.93	3.70	1.21	46.37
1897	2.90	2.16	3.03	3.10	6.52	2.51	10.99	5.04	2.00	1.49	4.49	3.55	47.78
1898	4.82	4.36	3.66	3.83	8.60	1.54	5.57	9.19	2.17	5.38	5.80	2.40	57.32
1899	4.73	4.19	5.65	1.92	2.13	4.93	6.04	1.57	5.08	1.28	1.85	2.30	41.67
1900	3.90	7.70	3.97	1.95	3.46	2.55	4.16	2.43	2.79	4.32	5.24	2.08	44.55
1901	1.60	0.55	6.37	8.97	6.62	1.47	4.97	12.80	4.75	2.75	1.38	7.74	59.97
1902	3.06	4.28	5.96	3.68	4.47	4.12	4.16	1.73	6.47	5.92	1.10	6.56	51.51
1903	3.65	3.77	4.59	3.46	0.57	9.22	3.07	7.80	3.17	7.61	2.44	4.09	53.44
1904	3.25	2.81	2.29	3.39	3.08	1.62	4.00	8.11	7.56	3.82	2.63	4.00	46.56
1905	7.37	1.67	3.99	2.70	0.55	5.96	3.83	6.41	4.37	3.27	2.14	2.81	45.07
1906	1.90	2.50	5.47	4.88	4.43	3.85	5.10	4.62	3.71	4.82	1.49	5.29	48.06
1907	4.66	4.20	3.51	3.57	5.30	4.92	1.35	1.74	11.85	9.16	6.60	4.88	61.74
1908	4.95	6.45	4.23	3.45	7.60	2.74	2.92	8.68	1.15	2.16	0.75	3.68	48.76
1909	4.67	6.57	5.11	7.51	1.62	3.46	1.93	6.33	4.43	1.20	3.27	4.95	51.05
1910	7.20	5.70	0.78	6.59	3.37	5.35	1.23	2.69	1.98	1.62	5.00	3.19	44.70
1911	3.07	3.30	4.39	4.00	1.91	3.57	2.32	6.67	2.80	6.30	4.59	3.22	46.14
1912	2.65	2.43	7.97	3.56	3.93	1.83	2.50	4.20	3.74	3.26	4.33	5.03	45.43
1913	3.98	2.94	6.18	6.14	3.76	1.14	2.35	3.47	4.34	9.00	2.88	2.97	49.15
Av.	4.34	4.28	4.68	3.55	3.82	3.50	4.59	5.54	4.46	4.07	3.98	3.98	50.79

RAINFALL IN THE VICINITY OF NEW YORK CITY.

1836–1854, Fort Columbus; 1855–1868, Deaf and Dumb Asylum; 1869–1913, Central Park Observatory, elevation 97 feet.

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1836	1.09	2.01	1.31	2.66	0.63	6.46	1.44	2.37	3.40	2.00	1.90	2.30	27.57
1837	2.70	3.70	8.20	7.50	9.50	8.50	5.90	6.30	2.10	2.11	2.90	6.10	65.51
1838	3.93	3.70	4.10	2.50	3.99	3.12	1.83	4.79	4.96	3.64	3.10	2.24	41.90
1839	0.69	2.05	2.46	3.35	8.37	4.94	1.35	4.92	3.59	1.45	2.19	7.61	42.97
1840	1.84	1.84	2.92	2.03	2.39	2.40	1.80	4.25	1.84	4.59	2.90	1.00	29.80
1841	5.30	0.80	2.35	3.93	3.95	4.65	4.90	2.50	2.90	4.40	3.70	2.70	42.08
1842	1.07	2.85	1.25	3.60	3.60	3.30	3.80	2.81	2.10	4.30	1.80	3.50	33.98
1843	1.00	2.31	2.13	2.14	1.00	0.76	1.64	15.26	3.06	5.91	2.82	3.34	41.37
1844	2.66	1.03	4.50	0.55	3.41	2.37	6.00	2.73	4.50	4.08	1.73	2.82	36.38
1845	4.87	3.22	3.33	1.22	1.75	3.70	1.75	3.21	2.62	2.50	3.40	2.51	34.08
1846	3.92	3.01	3.82	4.01	9.70	1.39	6.01	3.88	0.48	1.34	8.36	2.99	48.91
1847	4.62	5.74	8.48	1.53	2.18	6.78	1.62	6.93	12.20	2.13	6.29	6.35	64.85
1848	1.75	1.68	2.23	1.16	7.28	4.56	2.64	1.41	1.87	6.61	1.59	4.02	36.80
1849	0.61	2.26	4.87	0.62	3.47	0.78	1.43	4.63	1.55	5.63	1.88	4.01	31.74
1850	5.57	2.64	4.64	2.72	9.20	3.07	3.92	7.21	4.71	3.16	2.33	5.36	54.53
1851	1.46	4.50	1.70	6.94	4.73	0.90	4.72	3.47	1.26	2.95	4.53	3.72	40.88
1852	2.92	3.08	4.43	4.74	2.24	2.11	3.25	6.20	2.29	2.06	6.07	4.45	43.84
1853	4.14	4.98	2.03	3.32	5.80	4.80	4.40	5.50	5.49	3.90	6.80	1.04	52.20
1854	2.60	4.00	0.70	8.80	7.70	2.20	1.90	1.03	1.90	1.80	3.95	8.60	45.18
1855	4.77	5.12	2.83	2.86	4.90	5.83	5.06	2.90	1.51	7.37	3.00	6.86	53.01

RAINFALL IN THE VICINITY OF NEW YORK CITY.—*Continued.*

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1856	3.98	0.66	2.08	2.72	4.78	3.58	2.79	6.73	5.05	1.18	2.50	4.45	40.50
1857	4.99	1.69	2.32	9.05	6.72	5.43	6.13	3.90	4.26	1.67	1.30	6.42	53.88
1858	3.80	3.30	1.47	4.83	6.00	6.42	4.32	3.15	3.50	4.19	5.99	4.90	51.87
1859	5.78	5.59	8.21	5.10	1.57	4.60	4.76	4.12	6.45	1.75	3.37	4.42	55.72
1860	2.52	3.28	1.60	3.21	4.54	1.43	3.33	3.85	6.24	3.55	7.57	4.05	45.17
1861	4.81	2.45	5.78	5.62	6.03	4.24	2.89	5.52	4.03	3.46	8.09	1.73	54.65
1862	5.60	4.17	4.54	2.14	3.84	9.03	5.85	2.15	2.25	6.86	5.63	1.91	53.97
1863	5.45	7.04	5.77	5.69	4.58	1.43	8.60	4.59	1.05	4.09	3.88	4.86	57.03
1864	2.92	2.04	2.15	3.28	5.23	4.41	3.20	5.19	5.45	2.68	5.16	5.90	47.61
1865	3.40	4.06	8.32	4.14	5.56	10.42	5.21	2.23	4.21	4.94	4.19	6.30	62.98
1866	2.56	10.09	2.28	4.09	4.46	4.38	1.67	4.81	4.85	5.28	3.84	3.92	52.23
1867	2.54	5.53	4.09	2.47	5.70	10.18	5.76	7.68	0.78	5.12	2.25	2.56	54.66
1868	4.00	2.31	3.69	6.42	7.19	4.66	6.44	8.31	9.60	2.01	5.13	4.27	64.03
1869	2.53	6.87	4.61	1.39	4.15	4.40	3.20	1.76	2.81	6.48	2.03	5.02	45.25
1870	4.41	2.83	3.33	5.11	1.83	2.82	3.76	3.07	2.52	4.97	2.42	2.18	39.25
1871	2.07	2.72	5.54	3.03	4.04	7.05	5.57	5.60	2.34	7.50	3.56	2.24	51.26
1872	1.88	1.29	3.74	2.29	2.68	2.93	7.83	6.29	2.95	3.35	4.08	3.18	42.49
1873	5.34	3.80	2.09	4.16	3.69	1.28	4.61	9.56	3.14	2.73	4.63	2.96	47.99
1874	5.33	2.04	2.12	8.77	2.24	2.78	5.06	2.43	8.24	1.70	2.30	2.82	45.83
1875	3.17	2.62	3.48	3.08	1.33	2.72	4.89	8.97	1.89	2.85	3.78	2.12	40.90
1876	0.94	4.81	8.79	3.06	3.03	2.66	3.65	2.28	5.28	1.42	3.31	2.54	41.77
1877	2.62	1.24	5.56	2.73	0.95	2.80	5.73	2.77	1.33	8.14	5.62	0.68	40.17
1878	4.46	3.75	3.27	1.97	3.19	3.08	4.62	7.97	4.05	2.43	4.73	5.14	48.66
1879	2.63	2.02	3.41	4.33	2.02	3.15	3.58	7.95	2.37	0.43	2.20	4.92	39.01
1880	2.14	2.12	4.66	2.90	0.62	1.14	8.52	5.23	1.90	2.70	2.46	2.27	36.66
1881	4.80	4.93	5.81	0.95	3.20	5.35	1.25	0.86	0.97	1.60	2.36	4.18	36.26
1882	5.05	3.43	2.53	1.64	4.20	2.52	3.21	1.14	16.85	1.51	1.24	1.95	45.27
1883	2.68	4.21	1.49	3.71	2.83	3.32	3.21	1.82	3.25	4.53	1.52	3.20	35.77
1884	5.22	4.92	4.62	2.82	3.74	4.98	4.74	7.90	0.21	3.75	3.18	6.17	52.25
1885	3.06	4.56	0.90	2.19	1.86	1.32	3.59	5.67	0.41	5.18	4.17	2.46	35.37
1886	3.91	4.89	2.83	3.85	5.40	3.35	2.75	0.95	1.17	3.07	4.42	2.79	39.38
1887	4.42	5.96	3.07	2.79	0.34	7.76	5.29	3.59	1.93	2.43	2.02	4.39	43.99
1888	4.96	3.49	4.62	2.89	5.62	2.60	1.53	7.66	8.16	4.33	4.04	3.42	53.32
1889	4.97	2.21	2.64	5.47	2.89	2.39	11.89	3.28	6.92	2.61	9.97	1.92	57.16
1890	2.29	3.41	5.50	1.85	3.45	4.67	4.49	4.37	4.63	6.56	0.71	3.70	45.63
1891	6.12	4.12	3.61	2.38	2.45	1.48	3.94	4.51	2.49	2.60	2.30	3.55	39.55
1892	4.69	0.94	3.49	2.02	4.22	2.78	3.21	4.16	1.06	0.59	7.14	1.30	35.60
1893	2.33	6.14	3.54	5.19	4.77	2.59	1.13	8.72	1.92	5.30	3.55	3.08	48.26
1894	2.01	3.93	1.35	2.19	3.73	0.98	2.21	1.17	8.68	5.96	4.15	4.65	41.01
1895	5.01	0.46	2.26	3.31	2.02	2.47	4.54	4.16	0.62	4.21	3.83	2.48	35.37
1896	0.96	6.83	5.28	1.27	2.51	5.72	7.41	1.53	4.74	1.74	2.84	1.13	41.96
1897	3.00	2.52	2.39	2.67	5.77	2.95	9.56	3.77	1.81	0.72	4.52	4.87	44.55
1898	4.26	4.22	2.78	3.25	6.72	1.25	4.41	3.47	1.70	6.05	6.72	3.07	47.90
1899	3.97	3.91	5.77	1.74	1.09	2.26	4.47	3.41	6.12	2.13	1.79	1.91	38.57
1900	4.22	5.38	3.49	2.02	3.72	2.20	3.21	4.52	2.50	3.56	4.36	2.01	41.19
1901	1.66	0.55	5.47	6.62	6.43	1.00	7.64	6.55	2.42	2.35	0.99	7.01	48.69
1902	2.27	5.39	4.84	3.03	1.35	6.48	5.59	4.30	4.31	7.16	1.28	6.77	52.77
1903	4.18	4.70	4.23	3.44	0.30	9.78	3.92	6.73	3.67	13.31	0.97	3.09	58.32
1904	2.97	2.21	3.57	3.80	1.88	2.95	4.95	7.85	4.31	2.99	2.20	1.96	41.64
1905	2.77	2.01	3.49	2.39	0.72	3.77	3.05	4.81	5.84	3.55	1.67	3.37	37.44

RAINFALL IN THE VICINITY OF NEW YORK CITY. — *Concluded.*

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1906	2.69	2.47	5.04	5.90	5.53	1.26	4.54	1.43	2.49	4.19	1.06	3.58	40 18
1907	2.89	2.25	3.08	3.78	4.22	3.28	0.89	3.24	8.33	4.78	4.48	4.26	45.48
1908	3.76	5.86	2.38	2.27	8.51	1.27	3.80	6.01	1.91	1.38	0.71	3.19	41.05
1909	3.32	4.53	3.57	6.13	1.47	3.02	2.17	8.50	2.65	0.66	1.36	4.29	41.67
1910	4.64	3.15	1.02	5.00	1.49	6.03	0.49	1.07	1.42	3.23	4.30	1.88	33.72
1911	2.79	3.26	3.33	3.54	1.25	5.67	2.16	9.28	1.70	7.65	5.12	3.07	48.82
1912	2.38	2.73	7.70	3.53	5.40	1.57	2.56	2.75	4.14	4.10	3.53	5.01	45.40
1913	3.43	2.74	6.47	6.27	2 95	1.98	6.06	2.38	7 00	12.97	2.16	3.59	58 00
Av.	3.40	3.48	3.76	3.56	3.89	3.73	4.12	4 61	3.68	3.85	3.54	3.67	45.29

RAINFALL AT PLATTSBURG, N. Y. Elevation, 125 feet.
(1910 and 1911 observations at Harkness, N. Y. Elevation, 622 feet.)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1869	1.13	3.55	1.10	1.77	2.67	3.02	1.55	2.12	2.13	7.53	1.18	2.50	30.25
1870	2.79	2.34	0.58	0.69	0.39	2.81	1.91	1.31	2.54	2.70	1.29	1.26	20.61
1871	1.13	1.09	3.63	3.98	1.73	1.34	4.65	3.48	1.15	1.95	1.09	2.32	27.54
1872	0.68	1.42	1.17	1.66	2.37	2.85	4.72	5.86	3.27	3.40	2.16	1.59	31.15
1873	3.26	0.36	3.68	2.00	1.26	2.01	4.90	2.02	1.95	5.15	3.94	1.86	32 39
1874	3.69	1.96	1.83	3.60	3.89	2.40	9.18	1.53	4.06	1.24	2.24	1.04	36.66
1875	2.21	1.16	2.55	1.58	2.99	1.86	3.14	3.35	3.18	3.49	1.92	1.13	28.56
1876	1.39	2.51	2.25	1.23	0.80	3.04	1.21	0.37	4.06	1.34	0.76	2.01	20.97
1877	1.71	0.22	1.68	2.08	2.47	1.85	5.07	3.72	2.09	3.68	1.71	0.85	27.13
1878	1.60	0.66	1.61	2 85	2.47	1.31	3.53	7.00	2.44	2.88	3.01	3.33	32.69
1879	0.87	1.01	2.02	0.48	0.18	2.53	2.57	2.81	2.03	0.46	2.86	2.88	20.70
1880	1.75	2.96	1.21	1 27	1.49	2.02	2.00	1.65	2.43	4.54	2.67	0 98	24.97
1881	2.56	1.12	2 36	0.30	2.93	1.27	2.35	2 54	1.99	1.84	1.50	1.76	22 52
1882	1.06	1.96	2.70	0.86	1.70	4.78	7.22	2 01	4.72	1.04	0.54	1 69	30.28
1883	0.90	1.37	1.66	0.68	4.39	4.90	3.40	1.17	2.49	1.81	1.75	0.96	25.48
1884	1.88	1.84	3.49	1.08	2.29	1.60	1.98	2 19	1 69	2.42	2.03	1.26	23.75
1885	2.57	1.33	0.30	1.59	1.56	1.48	4 04	2.10	3.22	4.57	4.39	1.91	29.06
1886	1.15	1.22	1.42	2.06	1.48	4.72	3.77	3.97	2.36	0.76	2.30	0.17	25.38
1887	1.56	1.66	1.78	0.37	0.40	2.26	2.03	2.20	0.51	1.24	3.14	1.76	18.91
1888	0.59	0.20	1 95	1.27	3.20	1.88	1.12	5 23	3.76	2.98	3.90	2.36	28.44
1889	1.75	0.32	0.30	1.70	2.83	4.17	5.62	1.43	4 25	3.34	2.57	2 03	30.31
1890	2.78	2.40	2.68	1.46	4.40	3.35	4.04	5 82	2.87	2.92	2.27	2 45	37.44
1891	2.30	1.66	2.65	2.28	1.97	1.49	3.77	3.55	0.93	2.07	1.67	2.58	26 92
1892	4.30	2.47	1.36	0.97	4.07	7 62	5.21	7.18	1 68	1.12	2.74	1 44	40.16
1893	0.89	1.54	0.68	2.11	3.26	2.42	3.34	5 76	2 12	0.85	1.28	3.92	28 17
1894	2.04	1.37	1.91	1.14	4.14	3.52	2.52	0 89	2.79	3.03	2.82	2.55	28.72
1895	2.07	0.70	0.74	2.79	1.97	3.85	2.15	4.50	2.85	0.45	5.13	2.40	29.60
1896	2.05	6.21	4.95	0.85	1.85	2.80	5 00	5.95	2 85	1.68	2.19	0.87	37 25
1897	2.98	1.43	2.26	2.67	3.41	3.90	7.19	3.93	1.90	0.52	3.58	1.96	35 73
1898	5.26	3.19	1.29	1.95	1.70	2.62	2.09	5 82	3.37	3.70	3.08	2.07	36.14
1899	2.70	0 40	2.90	1.00	2.52	1 85	3 51	5 28	5.71	2.15	2.04	1 29	31 35
1900	3 46	3.16	4.28	0.83	2.38	4 21	1.79	3.24	2 14	1.00	8.82	2.83	38 14
1901	1.75	1.22	1 85	2.82	4 38	3.71	3 18	4 48	3 86	2.00	1.60	1 50	32 35
1902	0.90	1 60	**2.82**	1.80	4 10	3 74	4 30	2 70	1 80	2.95	0.87	2.50	30 08
1903	2.50	1.30	4.15	1.70	0.00	4 45	4 40	4 49	0 10	2.16	0.84	2 90	28 90
1904	2.74	0.50	0.20	2.56	2.25	2.22	3.30	4 73	**5.84**	2 86	**0.52**	0 20	27 92
1905	1.99	1.00	2.73	1 49	2 16	3.12	8.27	5 07	4 48	2.30	1.78	1 69	36 08

RAINFALL AT PLATTSBURG, N. Y.—*Continued.*

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1906	1.10	1.15	2.25	1.30	2.37	4.03	5.46	1.53	2.34	2.18	2.45	2.19	28.35
1907	1.10	1.03	1.65	2.24	2.95	3.45	2.50	0.90	6.95	2.70	1.23	1.10	27.80
1908	1.67	1.00	2.00	1.26	2.00	1.60	2.20	1.94	1.12	1.39	1.09	1.55	18.82
1909	2.82	2.54	2.89	0.98	0.79	**3.57**	**4.06**	2.19	3.22	0.62	1.45	1.67	26.80
1910	1.50	3.00	0.39	1.27	3.81	2.18	3.25	2.34	1.91	2.31	1.43	1.01	24.40
1911	0.99	1.11	2.03	0.56	0.95	3.21	1.81	2.60	2.75	2.38	1.14	2.02	21.55
1912	0.74	2.03	2.33	2.25	4.81	0.42	3.66	3.49	5.57	2.37	3.76	0.19	31.62
1913	2.06	0.78	3.81	1.82	2.09	1.45	3.78	1.15	2.92	3.94	1.30	0.99	26.09
Av.	1.98	1.62	2.09	1.63	2.40	2.86	3.70	3.28	2.85	2.40	2.27	1.77	28.85

RAINFALL AT SETAUKET, N. Y. Elevation, 40 feet.

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1886	3.76	7.08	3.18	4.21	3.13	3.68	7.43	3.00	1.03	4.15	3.43	4.43	48.51
1887	5.33	6.00	4.96	3.95	0.10	6.57	5.30	4.42	2.45	3.76	2.62	3.42	48.88
1888	5.49	3.27	7.32	2.88	4.49	1.69	1.61	5.60	6.44	4.76	4.83	3.08	51.46
1889	6.26	2.19	2.74	3.57	3.83	2.91	6.64	4.16	7.22	4.64	8.03	1.68	53.87
1890	1.87	3.00	6.56	3.40	3.50	2.97	5.25	4.27	6.53	10.20	0.74	5.65	53.94
1891	6.29	6.26	3.84	3.22	1.24	1.84	5.71	3.43	3.18	6.60	2.24	3.40	47.25
1892	4.79	1.40	3.73	1.82	3.65	1.79	3.12	4.76	3.67	0.90	8.22	1.56	39.41
1893	3.09	7.11	5.82	4.95	5.87	0.58	1.88	6.65	2.02	4.00	3.25	3.43	48.65
1894	3.63	4.40	1.34	3.11	4.40	1.17	0.63	2.61	5.26	8.86	6.02	4.60	46.03
1895	5.40	0.91	3.08	3.01	2.09	2.63	3.41	5.02	2.41	3.37	5.40	2.48	39.21
1896	1.48	6.46	4.81	1.02	3.10	4.10	2.74	2.35	3.62	2.87	3.21	1.62	37.38
1897	3.85	2.56	2.80	3.29	5.38	2.82	18.18	5.03	1.20	1.79	5.76	6.60	59.26
1898	4.00	4.82	3.40	4.90	8.30	0.62	7.81	6.56	1.85	7.08	6.28	2.38	58.00
1899	4.71	5.48	8.15	1.54	1.95	3.08	3.10	0.97	5.02	2.75	1.21	1.67	39.63
1900	4.92	5.88	4.77	1.53	5.12	1.38	5.05	5.90	2.31	2.97	4.88	2.63	47.34
1901	1.96	0.69	5.61	8.23	7.25	1.12	3.42	6.02	3.55	2.76	1.94	9.43	51.98
1902	1.95	5.47	5.85	3.26	0.98	5.09	2.41	0.85	6.63	7.32	1.63	7.46	48.90
1903	3.83	4.79	7.35	3.61	0.50	7.84	2.26	6.28	2.61	3.66	1.32	4.26	48.31
1904	3.84	2.93	3.35	6.26	2.83	2.40	3.60	7.51	3.78	3.10	2.08	3.63	45.31
1905	3.10	2.40	3.47	3.00	1.30	3.54	4.31	3.75	5.14	2.54	1.95	4.48	38.98
1906	3.56	2.57	5.03	3.57	4.53	3.19	8.62	4.73	1.07	9.20	1.87	4.07	52.01
1907	3.74	3.09	2.75	3.18	5.25	2.77	1.07	1.41	7.31	4.01	6.61	5.53	46.72
1908	4.13	5.74	2.82	2.61	4.93	0.88	1.84	7.39	1.38	1.38	0.88	3.78	37.76
1909	3.17	4.70	4.02	6.11	1.78	1.55	2.44	4.88	3.96	2.10	2.12	4.33	41.16
1910	7.62	2.96	1.56	2.85	2.89	3.51	0.78	0.89	1.18	1.59	4.86	2.87	33.56
1911	3.27	3.08	3.40	4.24	0.90	1.84	2.97	8.30	2.09	6.13	6.95	3.35	46.52
1912	2.48	2.30	7.77	5.95	3.39	0.57	1.93	3.02	3.71	1.07	4.15	1.95	41.32
1913	3.54	3.36	5.68	6.21	2.52	0.90	0.91	2.67	3.79	8.81	2.56	4.25	45.20
Av.	3.97	3.96	4.47	3.77	3.40	2.61	4.09	4.37	3.59	4.37	3.75	3.96	46.31

RAINFALL AT WAPPINGERS FALLS, N. Y. Elevation, 110 feet.

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1891	7.75	4.69	3.13	4.49	1.86	2.19	3.91	3.82	1.60	2.19	2.14	4.34	42.11
1892	6.08	1.31	3.31	0.61	6.15	4.21	6.03	7.81	2.06	0.64	6.71	1.76	46.68
1893	3.10	7.05	4.78	3.43	7.37	2.09	3.13	6.64	3.14	3.53	3.04	4.05	51.35
1894	2.45	3.43	1.57	2.68	5.84	1.01	1.46	1.17	4.65	5.98	3.27	4.61	38.12
1895	3.04	1.23	1.23	4.17	3.88	1.50	2.45	2.96	1.20	5.02	4.00	3.37	34.05
1896	1.36	6.19	7.84	1.18	3.58	3.52	5.40	2.46	7.01	3.34	3.17	1.93	46.98
1897	2.77	2.66	2.79	3.05	3.92	4.55	11.84	5.82	1.88	1.24	7.24	5.99	53.75
1898	5.17	4.51	3.62	5.16	7.65	2.47	3.68	7.75	2.48	3.42	5.74	2.45	54.10
1899	3.69	6.09	7.61	1.68	2.24	4.15	5.05	1.68	9.70	2.00	2.26	1.49	47.64
1900	2.80	6.99	4.58	1.71	4.43	2.82	4.00	3.05	2.35	3.67	4.81	2.27	43.48

RAINFALL AT WAPPINGERS FALLS, N. Y. — *Continued.*

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1901	2.64	1.33	6.22	9.07	6.36	3.08	7.58	9.42	3.28	2.42	2.37	6.03	59.80
1902	3.32	4.93	5.04	3.94	3.11	4.97	6.56	2.58	5.72	4.57	1.37	9.25	55.36
1903	3.56	6.08	4.72	3.19	5.92	20.63	6.25	11.87	1.54	11.66	2.66	3.98	82.06
1904	5.54	2.66	4.03	3.96	5.57	7.07	5.23	3.92	6.51	4.12	2.06	3 66	54.33
1905	6.10	1.85	3.07	3.29	1.84	3.71	4.68	5.02	6.10	4.07	2.56	3.06	45.35
1906	3.07	3.50	4.08	3.95	6.11	4.98	7.70	2.81	3.00	3.63	1.67	3.72	48.22
1907	3.68	2.40	1.89	3.14	4.61	5.85	3.24	1.63	8.20	7.47	5.23	4.28	51.62
1908	3.00	4.76	4.66	3.77	6.82	3.23	5.97	3.18	1.34	1.11	0.68	3.16	41.68
1909	4.31	5.62	2.52	5.42	2.63	4.59	2.70	6.47	4.27	1.21	2.29	3 34	45 37
1910	6.06	5.27	1.41	5.29	5.05	5.61	2.77	5.93	3.92	1.03	3.16	2 02	47.52
1911	2.67	2.08	2.37	3 67	1.52	4.99	4.62	7.08	3 42	8.64	2.69	1.78	45.53
1912	1 75	1.86	4.47	5 29	5.68	1 11	1.36	4.14	3.07	5.78	3.54	4.41	42.46
1913	4 06	2.85	6 77	6.02	3.41	1.72	1.44	3.93	2.58	8.47	2.99	2.72	46.96
Av.	3.83	3.88	3.99	3.83	4.59	4.35	4.65	4.83	3.87	4.14	3.29	3.64	48.89

RAINFALL AT YONKERS, N. Y. Elevation, 100 feet.

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1878	3.36	4.51	3.35	2.29	1.19	4.74	2.38	2.97	4.75	3.22	5.54	6.46	44.76
1879	3.72	3.46	4.98	5.16	2.67	5.00	5.60	8.24	3.70	0.58	1.97	4.65	49.73
1880	3.68	2.72	4.29	2.61	0 72	0.92	10.20	5.10	2.52	1 64	2 84	2.85	40.09
1881	4.28	5.32	5.95	1.13	2.30	6.78	2.64	1.10	1.02	3.62	2.90	5.82	42.86
1882	7.25	7 24	4.52	1.88	6.01	4 16	6.33	2.42	14.70	1.95	1.33	2.79	60.58
1883	4 18	6.61	1.43	4.41	3 50	5.01	3.00	2.01	4.71	13.86	3.83	4.84	57.69
1884	11 80	10.96	7.55	2.90	4.56	6.67	4.82	7.86	0.67	3.25	4.20	8.58	73.82
1885	9.79	13.33	1.61	0.90	1.97	1.64	6.85	5.05	0.73	6.73	3.08	2.97	54.65
1886	5.31	10 21	4.20	4.79	5 20	4.86	3.74	1.70	1.46	3.11	4.37	4.61	53.56
1887	4.11	7 10	3.83	3.39	0.00	11.14	5.72	6.13	3.34	3.93	1.52	6.23	56.44
1888	6.62	4 97	7.31	3.42	6.79	2.12	1.41	11.50	8.45	5.99	4.57	5.02	68.17
1889	8.30	1.93	2.88	8.33	2.52	2.15	22.72	4.90	8.02	2.88	8.84	2.74	76.21
1890	2.43	3.43	5 88	1 96	3.51	3.88	6.02	3.25	3.64	5.84	0.70	4 25	44 79
1891	10.55	2.32	4.15	3.19	2.47	0.96	2.80	2.87	1.57	2.87	2 63	2.54	38.92
1892	5 05	1.18	2.63	1.70	5.47	3.53	4.00	4.98	1.64	0.52	7.15	1.19	39.04
1893	2 78	3.53	4.23	4.52	5.37	3.22	1.65	7.70	2.55	5.72	4.00	4.25	49.52
1894	1.70	2.55	0 95	2.64	4.88	0.61	1.34	2.59	10.39	6.36	5.79	4.54	44.34
1895	5 18	0.00	2.47	3.49	0.99	1.65	5.98	2.99	1.26	4.28	4.79	3.03	36.11
1896	7 28	0.76	3.94	0 20	4 97	5.41	3.53	3.56	3.75	1.62	2.85	0 62	38 49
1897	2 79	2.16	3.04	3.07	5.52	3.72	11.56	2.17	1 42	0.87	4 48	5 25	46.05
1898	3.86	4.45	3 13	3.50	8.55	1.16	8.98	4.79	0.82	6.81	4 12	1.68	51 85
1899	4 96	2.90	5.75	2.32	3.65	3.32	6.57	1.57	4.51	1.99	2 03	2.86	42.43
1900	4 94	7.24	3.52	1.96	5.20	2.59	6.90	4 41	3.44	3.72	6.33	2 94	53 19
1901	2 10	0 00	8.71	9.82	7.49	0 25	10.55	10.04	1.45	3.42	1 43	10.08	65 34
1902	2 40	3.75	6 24	4.52	3.83	4 76	4.30	2.81	8 70	14 14	1.85	8 38	65 68
1903	7.60	5.45	8.77	8.54	0.16	13.16	5.70	16.53	5.45	9.58	1.50	2.72	85.16
1904	1.94	3.50	4.65	6.31	5.22	3.97	8.39	8.03	6.03	1.80	2.51	4 40	56.75
1905	7.50	0.66	4 84	3.52	1.17	4.64	4.70	5.90	5.50	2.81	1.98	4.42	47.64
1906	2.10	3.32	3.74	6.50	4.00	2.29	6.80	3.51	2.97	5.88	1.54	4.28	46.93
1907	4.16	0.50	4.62	3.21	6.74	4.14	1 34	1.85	9 44	6.13	6.25	4.19	52.57
1908	2.39	5.73	2.55	2.46	8.97	1.25	2.57	11.55	2.00	3.15	0.55	2.90	46.07
1909	2.28	6.37	4.31	7.57	1.81	3.86	3.60	9.52	3.86	1.09	1.24	4.40	49.91
1910	2 28	6.37	4 31	7.57	1.81	3.86	3.60	9.52	3.86	1.09	1.24	1.25	46.76
1911	0.62	2.03	3.34	3.65	1.50	4.78	2.05	6.44	1.80	7.95	5.80	3.95	43.91
1912	2.10	3.00	13 25	3 05	4 05	0.79	2.13	0.77	3 30	5 47	5.45	5.60	48.96
1913	4.47	4.78	7.40	6.07	3.22	0.90	1.71	5.89	3.15	12.98	1.65	3.80	56.02
Av.	4.61	4.29	4.68	3.96	3.83	3.72	5.34	5.34	4.07	4.63	3.41	4.20	52.08

CANADA.

Year	Brome, Que.	Chatham, N. B.	Cranbourne, Que.	Dorchester, N. B.	Father Point, Que.	Fredericton, N. B.	Grand Manan, N. B.	Halifax, N. S.	Montreal, Que.	Point Lepreaux, N. B.	Quebec, Que.	Richmond, Que.	Sherbrooke, Que.	St. Andrews, N. B.	St. John, N. B.	Truro, N. S.	Whitehead, N. S.	Yarmouth, N. S.
1861	...	...	...	...	...	...	...	...	...	...	...	...	...	...	49.73	...	...	...
1862	...	...	...	...	...	...	...	...	...	...	...	...	...	...	52.91	...	...	...
1863	...	...	...	...	...	...	...	...	...	...	...	...	...	...	52.36	...	...	...
1864	...	...	...	...	...	...	...	...	...	...	...	...	...	...	49.71	...	...	...
1865	...	...	...	...	...	...	...	...	...	...	...	...	...	...	50.23	...	...	...
1866	...	...	...	...	...	...	...	...	...	...	...	...	...	...	52.66	...	...	...
1867	...	...	...	...	...	...	...	...	...	...	...	...	...	...	55.53	...	...	...
1868	...	...	...	...	...	...	...	...	...	...	...	...	...	...	49.46	...	...	...
1869	...	...	...	...	...	...	...	54.53	...	...	...	...	...	...	51.68	...	...	...
1870	...	...	...	...	...	...	...	56.16	...	...	...	...	...	...	63.76	...	...	...
1871	...	...	...	...	...	...	...	51.14	33.96	...	32.72	...	...	...	46.58	...	...	...
1872	...	...	...	...	...	...	...	54.06	41.42	...	32.34	...	...	...	62.13	58.35	...	...
1873	...	...	...	...	...	...	...	55.44	...	...	48.55	...	...	...	46.72	...	...	...
1874	...	41.45	...	40.96	57.10	42.85	...	54.18	39.12	...	39.45	...	...	41.68	47.72	43.69	...	...
1875	...	47.51	...	46.37	32.50	45.37	...	51.27	39.69	...	42.82	...	...	37.53	52.12	43.93	...	...
1876	...	45.47	41.78	44.12	57.50	47.55	...	53.97	42.42	...	39.74	...	...	40.27	49.76	43.61	...	...
1877	28.68	46.00	41.20	47.09	32.24	40.21	...	57.51	32.89	...	36.30	...	...	30.99	42.92	38.85	...	...
1878	40.76	46.28	42.41	50.57	37.83	40.96	...	56.74	43.76	...	46.25	...	...	35.53	44.73	38.85	...	...
1879	33.16	45.85	47.98	41.32	35.65	47.37	...	47.84	37.98	...	52.39	...	...	40.08	50.81	59.59	...	...
1880	29.67	37.25	40.45	40.25	29.25	39.97	...	52.85	40.78	...	48.61	...	...	35.29	44.97	36.89	...	24.47
1881	27.67	43.85	36.34	42.72	32.35	49.60	...	51.76	31.78	...	36.58	...	...	50.25	51.52	39.54	...	47.31
1882	27.73	45.23	50.29	47.41	32.31	43.46	...	62.02	38.12	...	50.41	40.00	...	40.48	51.01	46.15	...	46.52
1883	26.58	36.79	52.50	36.20	19.04	36.88	...	58.11	39.32	...	43.13	42.43	...	37.97	50.73	...	...	49.20
1884	29.28	45.91	54.90	61.94	36.80	53.74	52.71	63.28	42.71	...	45.57	45.52	...	46.54	66.50	48.03	36.31	45.31
1885	35.67	45.55	48.58	47.17	35.30	44.40	43.40	56.63	51.89	...	38.69	35.73	...	40.81	58.51	45.69	41.98	49.39

CANADA — *Continued.*

Year	Brome, Que.	Chatham, N. B.	Cranbourne, Que.	Dorchester, N. B.	Father Point, Que.	Fredericton, N. B.	Grand Manan, N. B.	Halifax, N. S.	Montreal, Que.	Point Lepreaux, N. B.	Quebec, Que.	Richmond, Que.	Sherbrooke, Que.	St. Andrews, N. B.	St. John, N. B.	Truro, N. S.	Whitehead, N. S.	Yarmouth, N. S.
1886	35.24	37.96	43.62	42.18	35.36	38.43	41.51	57.29	38.48	...	38.40	37.91	...	37.96	52.39	39.12	...	48.53
1887	...	43.62	43.93	49.06	34.73	45.01	48.54	57.13	38.27	58.30	37.59	39.06	...	48.16	64.17	45.40	27.16	53.18
1888	39.72	45.16	59.22	48.55	47.31	48.56	56.26	66.29	44.31	61.26	48.21	49.01	...	50.87	63.95	41.50	37.46	70.88
1889	36.29	32.53	51.79	33.16	38.94	39.15	45.52	48.66	47.14	45.47	48.72	41.91	...	40.38	50.59	36.92	36.66	48.21
1890	42.04	44.76	...	56.13	30.30	48.45	46.58	60.10	45.42	52.74	45.09	45.53	...	40.88	60.38	46.65	47.74	52.63
1891	35.04	41.87	...	47.21	30.46	42.88	48.23	58.67	36.17	48.38	37.55	35.11	...	42.11	53.00	48.32	40.34	52.53
1892	46.90	42.56	...	38.54	30.45	45.73	44.15	53.69	42.30	46.77	34.54	43.20	...	38.60	48.22	44.22	43.74	52.01
1893	35.52	39.66	...	...	29.19	44.12	44.07	58.75	40.50	44.40	35.94	37.77	...	36.51	41.20	41.84	55.31	54.16
1894	21.41	33.03	...	...	28.06	...	35.30	45.81	31.30	38.16	42.17	33.44	...	30.79	37.03	35.58	40.02	35.20
1895	30.66	37.61	...	...	31.49	...	46.63	62.15	39.95	51.93	35.70	35.91	...	40.27	49.92	47.02	44.92	48.81
1896	33.27	37.87	...	...	36.95	39.16	42.28	69.86	40.07	40.85	40.90	41.90	...	34.75	50.01	47.63	44.25	46.79
1897	33.64	40.14	...	...	37.75	40.56	47.41	51.52	39.43	46.11	37.60	34.27	...	...	52.45	42.30	44.47	50.39
1898	33.52	38.32	...	...	28.93	46.06	56.00	60.48	44.50	46.08	41.08	...	...	...	51.35	49.73	44.70	54.81
1899	29.03	34.73	...	...	31.75	38.83	42.22	53.01	43.59	42.27	36.88	...	...	...	50.27	42.47	38.10	48.64
1900	48.49	36.31	...	...	31.80	51.19	62.86	59.70	52.22	51.32	41.48	34.70	...	...	59.91	56.66	47.87	60.32
1901	27.16	33.98	...	...	32.03	43.30	49.34	58.10	45.96	42.42	45.96	31.89	...	...	44.56	42.56	42.64	46.93
1902	45.19	46.65	...	...	44.23	49.65	53.83	51.92	46.76	37.05	46.39	...	...	...	49.58	41.00	42.57	52.66
1903	28.35	42.90	...	...	37.68	...	53.43	59.13	36.15	28.71	31.46	...	...	...	47.62	49.88	39.07	60.52
1904	34.56	38.55	...	...	36.63	41.97	53.11	57.20	44.72	33.96	42.37	...	44.09	...	44.84	47.01	30.92	45.53
1905	36.56	38.17	...	...	26.92	32.99	38.57	47.44	38.15	39.33	32.12	...	39.50	...	42.93	...	28.88	39.74
1906	38.63	39.88	...	...	31.43	...	50.81	64.14	37.83	44.93	33.76	...	38.45	...	50.84	46.60	49.19	52.42
1907	37.06	49.93	...	...	37.59	...	49.26	54.92	40.81	44.65	47.57	...	45.58	...	48.32	37.28	33.89	42.74
1908	29.78	35.72	...	...	36.66	39.13	40.85	64.87	42.53	37.06	43.98	...	32.82	...	41.80	49.33	37.26	45.65
1909	31.23	53.43	...	...	39.89	54.18	48.96	54.32	40.37	42.25	47.00	...	41.56	...	51.50	47.47	37.59	41.39
1910	31.81	44.43	...	...	36.88	45.56	33.57	67.36	41.82	39.34	41.30	...	38.92	...	48.90	...	46.53	40.63
1911	23.81	39.09	...	...	31.14	35.02	30.01	50.45	36.65	32.57	36.70	...	32.43	...	41.78	...	36.73	35.06
1912	44.18	50.48	...	...	41.91	54.62	...	58.11	44.23	43.93	47.46	...	45.45	...	51.85	45.22	...	43.15
1913	35.25	40.31	...	...	32.76	43.87	...	57.68	41.95	40.44	39.93	...	...	...	41.15	48.96	...	44.40
Av.	33.99	41.67	46.78	45.31	35.18	44.02	46.62	56.58	40.89	43.73	41.20	39.18	39.87	39.94	50.67	44.97	40.60	48.53

DISCUSSION.

Precipitation in the Croton and Catskill Watersheds as Affected by Altitude and Winds.

Mr. George G. Honness (*by letter*). It is believed that high altitudes acting as a barrier to moist winds from water surfaces — either the ocean or large lakes, such as the Great Lakes, have, in a general way, an influence on precipitation, and that the high altitudes influence the local thunder showers of the summer season.

Rainfall records of the Croton and Catskill watersheds and various Government stations are available and illustrate the effect of these conditions.

The Croton watershed is located about 50 to 75 miles from the seacoast, and is of an undulating character, largely used for agricultural purposes. A comparatively small area is wooded. As it is now developed, of the 360.4 sq. miles, 19.3 sq. miles are water surface. The highest elevation in the Croton watershed is about 1 300 ft. above sea level, the entire drainage area being above Elev. 200. In steepness of slopes it compares with the Wachusett watershed; it is steeper than the Sudbury and not so steep as the Esopus watershed of the Catskill Mountain region, now being developed by the city of New York.

The Catskill watersheds are located about 100 to 150 miles from the seacoast. In this region there are four principal drainage areas: the Rondout, Esopus, Schoharie, and Catskill creeks, a portion of the drainage area of each being the proposed source of an additional water supply of 500 million gal. daily for New York City. The Esopus, 257 sq. miles, and the Rondout, 100 sq. miles, are similar in character, both being largely covered with a second growth of timber. The slopes are steep and rocky, and where rock does not outcrop, the cover is of an impervious glacial drift. These are the influences which make for the high percentage of run-off, and for both these streams it is larger than for the Croton River, Schoharie Creek, and Catskill Creek.

Table 1 shows a comparison between the Croton River and the Esopus Creek, and, although the average rainfall for the Croton and Esopus are about the same, this table clearly shows that a far greater yield per sq. mile can be secured from the Esopus.

TABLE 1.

PERCENTAGE OF RUN-OFF TO RAINFALL, ESOPUS AND CROTON WATERSHEDS, 1906–1913.

Year.	Run-off.	
	Croton. Per Cent.	Esopus. Per Cent.
1906	42.6	Run-off records available from October only.
1907	50.4	67
1908	47.1	64
1909	39.5	58
1910	45.1	66
1911	41	62
1912	50	66
1913	57	69.5

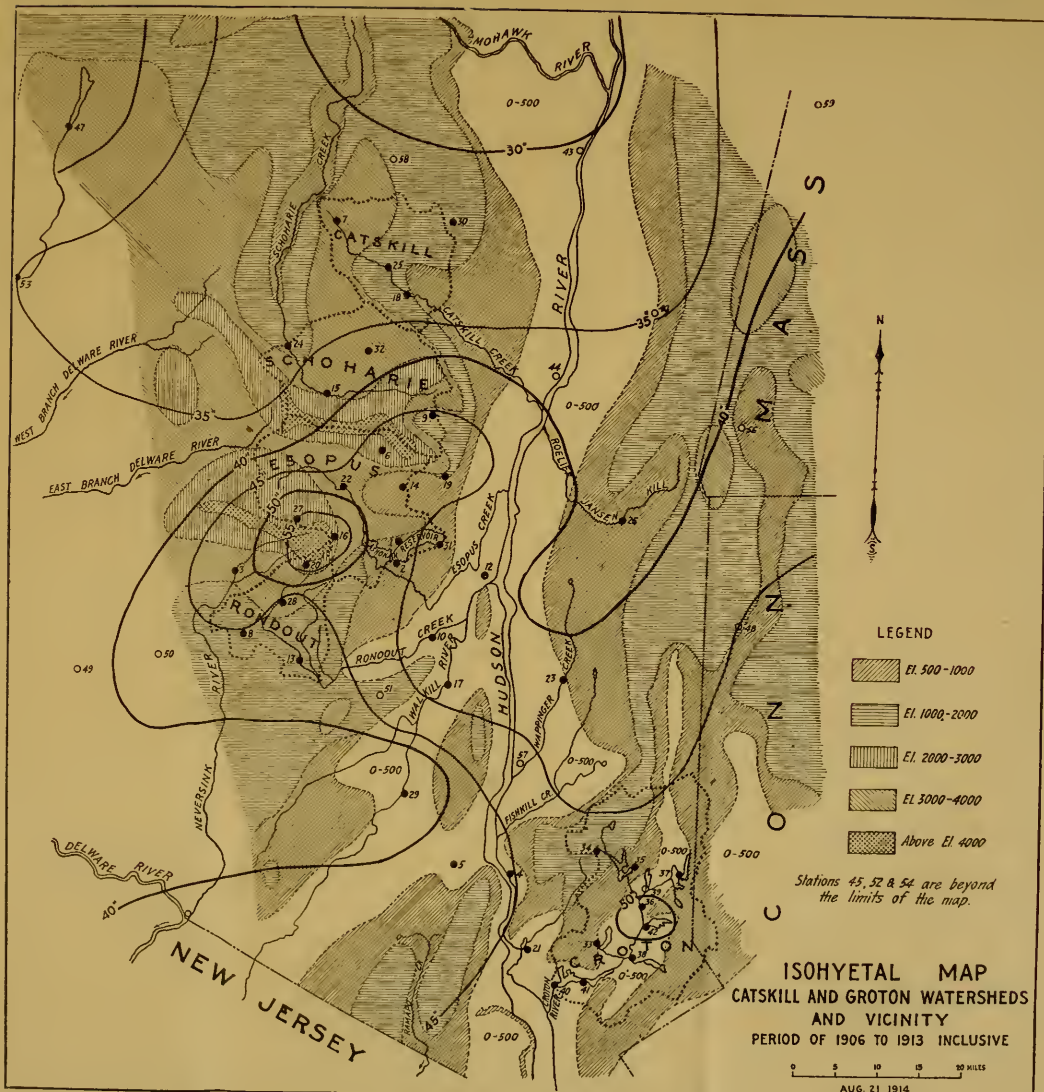
Run-off is natural flow of steam reduced to equivalent in inches over entire watershed.

The Schoharie is well wooded on the southern slopes, but the balance of the drainage area is given over to agriculture. The 228 sq. miles of this drainage area now under consideration for New York City's water supply is in the height of the mountain country, and the steep slopes yield a large percentage of run-off.

The Catskill Creek drainage area is mostly cleared land used for agriculture. It is undulating and occupies the flatter slopes of the northerly limits of the Catskill Mountain region. The slopes are much flatter, and the precipitation and per cent. of run-off is the smallest of the four areas.

The elevation of the Esopus drainage area ranges from 400 ft. to 4 200 ft. above sea level, 34 per cent. of the area being above Elev. 2 000. In the Rondout the range of elevation is from Elev. 650 to Elev. 3 850; the Schoharie, from Elev. 1 150 to Elev. 4 025, with 52 per cent. at Elev. 2 000 or higher; the Catskill, from Elev. 500 to Elev. 2 800, with but 10 per cent. at Elev. 2 000 or higher.

Records of precipitation on the Croton drainage area have been kept by the Department of Water Supply, Gas, and Electricity for many years, the location of the gages being such that


MOHAWK RIVER
HUDSON RIVER
CATSKILL
CATSKILL CREEK
SCHOHARIE
SCHOHARIE CREEK
ESOPUS
ESOPUS CREEK
RONDOUT
RONDOUT CREEK
WALLKILL RIVER
ROELIFF JANSEN KILL
WAPPINGER CREEK
FISHKILL CR.
CROTON
CROTON RIVER
NEVERSINK RIVER
WEST BRANCH DELAWARE RIVER
EAST BRANCH DELAWARE RIVER
DELAWARE RIVER
NEW JERSEY
MASS
CONN
ASHOKAN RESERVOIR
0-500
30°
35°
40°
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50°
55°
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LEGEND
El. 500-1000
El. 1000-2000
El. 2000-3000
El. 3000-4000
Above El. 4000
Stations 45, 52 & 54 are beyond the limits of the map.
ISOHYETAL MAP
CATSKILL AND GROTON WATERSHEDS
AND VICINITY
PERIOD OF 1906 TO 1913 INCLUSIVE
0 5 10 15 20 MILES
AUG. 21, 1914

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a numerical average gives what may be properly called an average for the entire area.

In the Catskill Mountain region the Board of Water Supply established gages in 1906, giving proper consideration to their elevation to secure the best average results, having in mind that the precipitation is higher in the higher altitudes. It is a fact well known by those familiar with this region that throughout the year the higher mountain peaks are frequently enveloped in mist, and showers are noticed on the mountains and in the higher hollows when fair weather prevails in the valley. The gages at the higher elevations invariably show a materially greater precipitation, the difference being as much as 15 in. per year. This fact led to an effort to weight the precipitation in accordance with elevations, giving a certain portion of the entire area to each gage. The average results obtained by this means differed only slightly from the numerical average, and this method was discontinued. This agreement of different methods may be taken as indicating that the selection of gage locations was well made.

Another influence of high altitudes is the greater snowfall, which has been noted to be as much as 11 ft. at Hunter Mountain. From the geological nature of the high mountain areas and the character of forest cover, the snow and ice are protected from evaporation during the winter months and add to the run-off during the spring and early summer months to a surprising degree; as an example, in March, 1910, less than an inch of rain fell, but the run-off recorded was about 8 in.; in April of the same year, with 10 in. of rainfall, the run-off recorded was 9 in.

Table 2 gives the location of the rain gages and their approximate elevations, and the rainfall for each year from 1906 to 1913, inclusive. The table gives the records of gages kept by the Board of Water Supply, the Department of Water Supply, Gas, and Electricity, and the United States Weather Bureau in the vicinity of the watersheds under consideration. An effort has been made to delimit areas between different variations of elevations as shown on a map entitled "Isohyetal Map of the Croton and Catskill Watersheds and Vicinity, Period 1906-1913, inclusive." An examination of the map indicates the precipitation in the Croton and Esopus is substantially the same and materially higher than

TABLE 2.

Rainfall Data, 1906–1913, for Isohyetal Map.

Board of Water Supply Records.

August 21, 1914.

Station.			Rainfall in Inches.								
No.	Name.	Elev.	1906	1907	1908	1909	1910	1911	1912	1913	Average
1	Ashokan..........	660	47.9	50.6	44.1	51.8	51.3	46.0	50.0	46.3	48.5
2	Brown's Station....	540	....	47.0	42.0	48.8	45.2	45.4	46.6	46.7	46.0
3	Claryville.........	1 750	....	50.2	44.3	44.2	47.1	46.1	48.3	52.8	47.6
4	Cold Spring.......	200	....	49.4	39.9	42.6	39.6	46.4	48.2	48.9	45.0
5	Cornwall.........	200	....	51.9	37.6	44.6	42.8	44.8	39.7	44.4	43.7
6	Edgewood.........	1 900	47.8	52.9	47.0	46.4	48.6	40.6	53.1	50.4	48.4
7	Franklinton	1 175	....	37.7	28.3	31.5	31.6	28.9	31.0	35.7	32.1
8	Grahamsville......	900	41.7	43.2	41.7	44.1	42.5	46.6	45.4	50.3	44.8
9	Haines Falls.......	1 910	....	52.6	48.5	47.3	48.2	38.4	40.8	42.5	45.5
10	High Falls.........	200	...	45.0	38.9	42.8	39.4	43.8	36.8	38.6	40.7
11	Highmount........	1 900	42.8	41.6	34.7	35.6	40.3	37.3	45.1	39.5	39.6
12	Kingston..........	190	....	42.8	37.2	41.8	41.0	42.4	41.8	40.3	41.1
13	Lackawack........	620	42.9	44.4	39.2	39.4	43.8	41.9	41.7	48.4	42.7
14	Lake Hill	1 200	46.3	49.2	46.5	50.2	46.7	42.6	47.9	46.8	47.0
15	Lexington.........	1 440	....	36.9	32.5	37.4	38.7	30.1	38.8	44.0	36.9
16	Moonhaw.........	1 200	....	57.8	54.8	62.3	58.6	56.5	60.9	61.9	59.0
17	New Paltz.........	200	....	46.5	40.7	40.0	40.7	42.1	40.3	43.0	41.9
18	Oak Hill..........	650	....	36.7	32.0	35.4	33.7	32.9	36.0	34.9	34.5
19	Overlook..........	3 000	....	....	46.4	54.8	49.2	41.5	46.8	46.1	47.5
20	Peekamoose.......	2 300	57.6	56.7	58.7	56.1	57.7	57.2	61.1	61.6	58.3
21	Peekskill..........	150	....	55.8	43.7	43.1	40.1	46.4	43.4	50.0	46.1
22	Phoenicia.........	750	44.5	46.8	45.1	45.9	48.6	41.0	50.4	50.2	46.6
23	Pleasant Valley....	220	....	....	33.6	38.5	41.8	48.0	39.1	42.6	40.6
24	Prattsville.........	1 165	....	41.6	28.2	32.1	37.0	30.4	33.4	33.8	33.8
25	Preston Hollow....	850	....	34.4	30.8	34.2	31.8	32.4	33.5	36.0	33.3
26	Silvernails........	380	....	....	30.6	36.3	35.7	41.5	41.7	36.1	37.0
27	Slide Mountain.....	1 900	58.7	53.4	50.9	54.6	57.8	49.0	61.8	58.1	55.6
28	Sundown..........	1 000	47.0	48.1	40.5	43.6	45.2	42.7	40.7	49.2	44.6
29	Walden...	400	....	42.4	29.1	36.3	40.2	35.9	35.3	....	36.5
30	Westerlo..........	1 160	....	35.3	31.5	33.1	31.0	30.3	39.1	32.4	33.2
31	West Hurley.......	565	....	47.4	42.0	46.7	43.8	40.1	46.8	42.9	44.2
32	Windham.........	1 500	....	...	36.3	36.7	41.1	28.9	35.4	35.3	35.6

Department of Water Supply, Gas, and Electricity Records.

33	Amawalk..........	400	47.0	57.6	45.1	48.1	41.9	48.1	44.0	50.4	47.8
34	Boyd Corners......	600	48.7	56.2	40.1	51.6	42.1	52.9	50.3	51.2	49.1
35	Carmel Reservoir...	500	50.6	57.9	39.1	51.9	44.9	50.1	48.1	49.6	49.0
36	Croton Falls.......	250	....	....	36.0	46.9	39.7	44.5	44.4	47.0	43.1
37	East Branch.......	400	44.0	56.4	38.8	50.1	42.0	45.2	43.9	47.7	46.0
38	Katonah..........	250	47.7	54.1	43.2	48.0	41.6	46.9	46.0	52.2	47.5
39	Middle Branch.....	400	46.5	59.9	41.9	51.6	45.1	51.7	44.5	46.9	48.5
40	New Croton.......	200	42.6	51.7	42,4	....	....	....	...	....	....
41	Old Croton........	200	48.1	61.2	48.7	51.0	44.7	46.1	45.4	49.2	49.3
42	Titicus............	300	52.8	65.1	47.4	56.6	41.2	46.9	43.8	49.8	50.4

TABLE 2.—*Continued.*

United States Weather Bureau Records.

Station.			Rainfall in Inches.								
No.	Name.	Elev.	1906	1907	1908	1909	1910	1911	1912	1913	Average
43	Albany..........	97	32.5	33.6	28.4	28.0	28.5	32.1	32.1	26.4	30.2
44	Athens...........	90	38.2	42.7	31.6	35.6	37.3	41.2	37.4	30.6	36.8
45	Binghamton.......	875	32.1	29.8	27.2	26.8	32.0	27.1	37.9	27.6	30.0
46	Chatham.........	470	37.9	40.0	26.5	34.9	32.3	36.7	36.5	32.4	34.6
47	Cooperstown......	1 250	48.8	46.6	38.4	44.2	43.8	44.2	47.1	37.6	43.8
48	Cream Hill........	1 300	46.3	55.8	40.3	44.8	45.6	44.4	44.9	43.1	45.6
49	Jeffersonville.......	1 240	39.6	35.7	36.7	35.0	34.5	41.3	38.3	43.5	38.1
50	Liberty..........	2 300	43.2	43.1	42.8	42.3	39.2	44.7	46.3	44.9	43.3
51	Mohonk Lake.....	1 245	46.8	51.3	39.9	48.5	53.1	48.4	41.4	46.2	46.9
52	New Lisbon......	1 234	43.6	41.2	33.6	38.8	35.9	36.3	40.3	37.5	38.4
53	Oneonta..........	1 112	41.2	39.5	31.8	34.2	29.8	31.7	34.3	34.4	31.6
54	Orford............	916	42.4	41.5	36.6	36.8	43.5	37.7	41.3	37.8	39.7
55	Port Jervis..	470	38.9	44.5	37.5	38.8	38.8	45.8	37.3	46.9	41.1
56	South Egremont...	764	42.7	50.6	35.4	44.7	40.9	41.7	....	....	43.2
57	Wappingers Falls...	110	48.2	51.6	41.7	45.4	47.5	45.5	42.5	47.0	46.2
58	West Berne........	946	32.2	36.1	28.0	30.0	28.6	26.1	32.9	32.3	30.8
59	Williamstown.....	711	36.1	37.6	30.5	36.3	37.9	32.0	36.3	32.8	39.0

in the territory north of the Croton and north and northwest of the Catskills. In the Croton the influence of the higher elevations of the northerly divide and the Hudson River Highlands is believed to have increased the precipitation from the moist winds blowing from the south and southeast. The same conditions obtain in the Rondout and Esopus drainage areas of the Catskill watersheds, they being largely on the southerly and easterly slopes. In the drainage areas of the Schoharie and Catskill creeks, the other two principal areas of the Catskill region, the precipitation is materially less, and to the northwest of these areas the precipitation is still less, the moist winds from the ocean having been interrupted by the high altitudes of the Catskills and being beyond the influence of the moisture-laden winds from the Great Lakes.

In the Catskill region the local thundershowers of the summer time, which are frequently of considerable intensity, apparently have their origin in the high mountains of the Wittenberg range and move northeasterly across the Catskill region.

In the Croton the influence of the Hudson River valley, with the highlands on the west bank, on the locally created thunderstorms is material.

The records of rainfall and the isohyetal map are made available for others who wish to consider the effects of winds and altitudes to reach conclusions.

The hydrographic work of the Catskill region for the Board of Water Supply is under the direction of Sidney K. Clapp, assistant engineer, with Frederick J. Rehn, assistant engineer, as his assistant.

PROCEEDINGS.

Pemberton Inn, June 16, 1915.

The June meeting of the New England Water Works Association was held at Pemberton Inn with the Boston Society of Civil Engineers, on June 15, 1915. Vice-President George F. Merrill presided.

The following members and guests were present:

Honorary Members.

R. C. P. Coggeshall, Albert S. Glover, F. E. Hall. — 3.

Members.

R. C. Allen, J. M. Anderson, G. F. Ashton, L. M. Bancroft, C. H. Bartlett, A. E. Blackmer, E. M. Blake, M. L. Brown, James Burnie, T. J. Carmody, F. H. Carter, J. E. Conley, H. J. Croughwell, J. M. Diven, William Dotten, John Doyle, E. R. Dyer, E. D. Eldredge, G. C. Emerson, G. F. Evans, S. F. Ferguson, G. H. Finneran, James Fitzgerald, F. L. Fuller, H. T. Gidley, F. J. Gifford, T. C. Gleason, J. M. Goodell, C. R. Gow, J. W. Graham, J. O. Hall, D. A. Heffernan, J. L. Howard, A. C. Howes, C. E. Johnson, W. S. Johnson, Willard Kent, G. A. King, C. F. Knowlton, E. J. Lonergan, E. J. Looney, F. A. McInnes, Hugh McLean, H. V. Macksey, A. D. Marble, W. E. Maybury, John Mayo, J. H. Mendell, G. F. Merrill, H. A. Miller, F. L. Northrop, Isaac Osgood, H. N. Parker, J. H. Perkins, Ransom Rowe, G. A. Sampson, A. L. Sawyer, J. E. Sheldon, C. W. Sherman, E. C. Sherman, H. L. Sherman, H. H. Sinclair, G. A. Stacy, G. T. Staples, W. F. Sullivan, H. A. Symonds, R. J. Thomas, L. D. Thorpe, A. H. Tillson, S. E. Tinkham, D. N. Tower, C. H. Tuttle, J. H. Walsh, L. R. Washburn, R. S. Weston, F. B. Wilkins, I. S. Wood, L. C. Wright. — 78.

Associates.

Ashton Valve Co., by A. H. Ashton; Builders Iron Foundry, by A. B. Coulters; Chapman Valve Mfg. Co., by J. T. Mulgrew and H. L. Dickinson; Darling Pump and Mfg. Co., Ltd., by H. A. Snyder; *Engineering Record*, by I. S. Holbrook; Goulds Mfg. Co., by S. G. Taylor; Hersey Mfg. Co., by

Albert S. Glover, W. A. Hersey, and J. H. Smith; Lead Lined Iron Pipe Co., by T. E. Dwyer; Ludlow Valve Mfg. Co., by A. R. Taylor and G. A. Miller; Macbee Cement Lined Pipe Co., by J. D. McBride; Mueller Mfg. Co., by G. A. Caldwell; National Meter Co., by J. G. Lufkin and H. L. Weston; Neptune Meter Co., by H. H. Kinsey and R. D. Wertz; Pittsburgh Meter Co., by J. W. Turner; Rensselaer Valve Co., by F. S. Bates and C. L. Brown; Ross Valve Mfg. Co., by William Ross; A. P. Smith Mfg. Co., by F. L. Northrop; Standard Cast Iron Pipe and Foundry Co., by W. F. Woodburn; Thomson Meter Co., by E. M. Shedd; Union Water Meter Co., by F. E. Hall; United States Cast Iron Pipe and Foundry Co., by M. G. Sackett; Water Works Equipment Co., by W. H. Van Winkle; R. D. Wood & Co., by H. M. Simmons; Henry R. Worthington, by Samuel Harrison, S. P. Howard, and W. F. Bird. — 33.

GUESTS.

Maine: Portland, George Sydleman. *New Hampshire:* Henniker, E. N. Cogswell. *Massachusetts:* Belmont, Mrs. E. C. Sherman, Mrs. C. W. Sherman; Boston, Mr. and Mrs. E. S. Dorr, Mr. and Mrs. H. N. Cheney, Miss Elizabeth Thorpe, Mrs. J. L. Howard, Mrs. S. E. Tinkham, Miss Mary E. Evans, Mrs. G. T. Sampson, Miss H. R. Sampson, Mr. and Mrs. L. Lee Street, Mrs. F. A. McInnes, Mr. and Mrs. E. W. Howe, Mr. and Mrs. H. L. Ripley, Mr. and Mrs. G. G. Shedd, Mr. and Mrs. F. C. Shepherd, Mrs. H. A. Symonds, Mrs. Morton J. Fitch, Miss Miller, Mrs. G. A. Caldwell, A. L. Gammage, Ellery Kinsey, J. G. Andrews, J. W. Stinson, A. H. Blake, E. P. Bliss, G. C. Ambrose, C. F. Glavin, H. L. Hammond, Allen Symonds, C. J. McCarthy, A. W. Parker, C. H. Vom Baur, Frank L. Preble, Horace T. Almy, Frederic Bonnet, Jr., J. M. Cashman, C. D. Bryant, B. R. Chapman, John H. Coghlan, J. W. Rollins, G. T. Sampson, Ernest R. Kimball, L. C. Wason; Braintree, Mrs. W. E. Maybury; Bridgewater, Mrs. John Mayo, Miss Eulah Hopkins; Brookline, Mr. and Mrs. N. S. Brock, Mr. and Mrs. W. T. Davis, Mrs. H. H. Kinsey; Cohasset, Mrs. D. N. Tower, Mr. and Mrs. Caleb Lothrop; Concord, John M. Keyes, Dr. Charles H. Spencer; Dedham, W. F. Whitman; Fall River, Mrs. F. J. Gifford; Framingham, W. F. Howland; Holyoke, Mrs. T. J. Carmody, Miss Helen Hanley, Catherine Sullivan, Mrs. Hugh McLean; Lowell, Mrs. R. J. Thomas, Miss Marion Thomas; Manchester, Mrs. G. F. Evans, Thomas Tonsello; Milton, Mrs. D. A. Heffernan; Norwood, C. A. Bingham; Onset, Neddie Eldredge; Peabody, Frank Emerson; Plymouth, T. W. Bailey; Reading, Mrs. L. M. Bancroft; Somerville, Mrs. Samuel Harrison, Mrs. C. F. Knowlton, Mrs. E. Martin; Taunton, Mrs. G. A. King, Mr. and Mrs. A. K. Crowell; Walpole, Mr. and Mrs. Edmund Grover, Mr. and Mrs. Stanley Grover; Wellesley, Mrs. C. E. Sammons, Miss Pearl Jones, Mrs. F. L. Fuller; West Roxbury, Mrs. C. R. Gow; Winchester, H. W. Dotten. *Rhode Island:* Narragansett, Mrs. Willard Kent; Providence, Mrs. I. S. Wood. *New York:* Alfred, Dr. F. C. Binns; Buffalo, D. A. DeCrow; New York City, Mr. and Mrs. A. S. Tuttle; Troy, Mrs. F. S. Bates. — 106.

Upon recommendation of the Executive Committee the following eighty-two applicants were elected to membership in the Association:

Robert E. Andrews, hydraulic engineer, National Board of Fire Underwriters, New York, N. Y.; James W. Armstrong, engineer, Filtration Division, Baltimore City Water Department, Baltimore, Md.; George L. Bean, civil engineer, Philadelphia, Pa.; David V. Bell, superintendent water companies U. P. R. R. Co., Rock Springs, Wyo.; William H. Boardman, Philadelphia, Pa.; Bertram Brewer, superintendent Water Department, Waltham, Mass.; Guy Britton, civil engineer, Simons, Ohio; John N. Brooks, civil engineer, Douglaston, N. Y.; Irving C. Bull, chemical expert, 100 Maiden Lane, New York, N. Y.; C. C. Carlisle, consulting engineer, Cheyenne, Wyo.; J. H. Clowes, expert accountant, New York, N. Y.; Edward N. Cogswell, chairman Board of Water Commissioners, Henniker, N. H.; Clement K. Corbin, president Bergen Water Company, Jersey City, N. J.; David Davis, Litchfield, Ill.; E. E. Davis, superintendent water works, Richmond, Va.; W. C. Davisson, vice-president and treasurer West Virginia Water and Electric Company, Charleston, W. Va.; Robert C. Dennett, hydraulic engineer, National Board Fire Underwriters, New York, N. Y.; Howard A. Dill, treasurer water works, Richmond, Ind.; Fred I. Dixon, water engineer, Ashton-under-Lyne, England; J. H. Dockweiler, consulting engineer, San Francisco, Calif.; Chester F. Drake, division superintendent, Filtration Division, Bureau of Water, Pittsburgh, Pa.; Arthur W. Dudley, consulting engineer, Manchester, N. H.; Guy Eldredge, chemist, Fort Worth, Tex.; R. G. England, civil engineer, Jackson, Mich.; John C. Flanagan, St. Paul, Minn.; H. V. Gates, civil engineer, Hillsboro, Ore.; Weston Gavett, analyst, City Water Company, East St. Louis, Ill.; W. R. Gelston, superintendent, Citizens Water Works Company, Quincy, Ill.; William H. Gould, sanitary engineer, Toledo, Ohio; Samuel A. Greeley, assistant engineer, Sanitary District of Chicago, Winnetka, Ill.; Frederick Green, general superintendent Commonwealth Water and Light Company, Summit, N. J.; S. C. Hadden, editor *Engineering and Contracting*, Chicago, Ill.; Harry R. Hall, principal assistant engineer, Maryland State Department of Health, Baltimore, Md.; L. V. Harper, manager Chelan Electric Company, Chelan, Wash.; C. A. Haskins, engineer Kansas State Board of Health, Lawrence, Kan.; T. Chalkley Hatton, consulting engineer, Milwaukee, Wis.; W. F. Howland, water registrar, Framingham, Mass.; E. W. Humphreys, consulting engineer, Erie, Pa.; H. Hymmen, superintendent Berlin Water Works, Berlin, Ont.; C. A. Jennings,

superintendent of filtration, Union Stock Yard and Transit Company, Union Stock Yards, Chicago, Ill.; Hervey E. Keeler, president Rogers Park Water Company, Chicago, Ill.; A. H. Kneen, Philadelphia, Pa.; John Knickerbacker, Troy, N. Y.; Stuart K. Knox, civil and hydraulic engineer, Montclair, N. J.; A. G. Levy, assistant director New Orleans Purification Plants, New Orleans, La.; William McCarthy, superintendent water works, Bluefield, W. Va.; H. C. McRae, International Joint Commission, Detroit, Mich.; Robert A. McKim, civil engineer, New York, N. Y.; John N. MacGonigle, vice-president and manager Miami Water Company, Miami, Fla.; Robert B. Morse, chief engineer, Maryland State Department of Health, Baltimore, Md.; A. R. Murphy, Fountain City, Tenn.; M. M. O'Shaughnessy, San Francisco, Calif.; William Perry, consulting hydraulic engineer, Montreal, Canada; Charles H. Pierce, district engineer, New England District, United States Geological Survey, Melrose, Mass.; Seabury G. Pollard, consulting hydraulic engineer, Cincinnati, Ohio; Andrew J. Provost, Jr., consulting sanitary and hydraulic engineer, New York, N. Y.; W. C. N. Randolph, Jr., superintendent water works, Lynchburg, Va.; Col. Henry N. Ruttan, Winnipeg, Manitoba; Robert L. Sackett, dean of engineering, State College, Pa.; C. B. Salmon, Beloit, Wis.; Fred D. Sayer, borough engineer and superintendent water, Brookville, Pa.; Frederick W. Schwartz, assistant professor analytical chemistry, Rensselaer Polytechnic Institute, Albany, N. Y.; George E. Schoemaker, secretary Waterloo Water Works, Waterloo, Ia.; Hervey K. Skinner, water commissioner, Wakefield, Mass.; E. H. Smith, manager New Jersey Water Service Company, Haddonfield, N. J.; L. B. Smith, manager Westmoreland Water Company, Greensburg, Pa.; Arthur N. Talbot, professor municipal and sanitary engineering, University of Illinois, Urbana, Ill.; Frank Talbott, superintendent and treasurer Water, Gas and Electric Departments, Danville, Va.; H. G. H. Tarr, manager Sales Machinery Department, R. D. Woods & Co., Philadelphia, Pa.; Robert K. Tomlin, managing editor *Engineering Record*, New York, N. Y.; Edward E. Wall, water commissioner, St. Louis, Mo.; G. L. Watters, hydraulic engineer, Lehigh Valley Railroad, South Bethlehem, Pa.; Vernon F. West, treasurer Rensselaer (N. Y.) Water Company, Portland, Me.; Theodore T. Whitney, Jr., chairman Board of Water Commissioners, Milton, Mass.; William A. Wilcox, president Waterloo (N. Y.) Water Company, Scranton, Pa.; Ernest C. Willard, civil engineer, Seattle, Wash.; Edgar K. Wilson, civil engineer, New York, N. Y.; John B. Wright, commissioner of public works, Amsterdam, N. Y.; A. J. Yeager, civil engineer, Buffalo, N. Y.; Charles W. Young, president Barnstable Water Company, Winchester, Mass. — 80.

Associates: John Fox & Company, New York, N. Y., and C. H. Vom Baur, Boston, Mass. — 2.

New York, N. Y.,
September 7, 8, 9, 1915.

The thirty-fourth annual convention of the New England Water Works Association was held at New York, N. Y., September 7, 8, and 9, 1915, convention headquarters being at the Hotel Waldorf-Astoria, and the sessions of the convention being held in the Astor Gallery, in rooms adjoining which the associates displayed their exhibits.

The following-named members and guests were in attendance:

Honorary Members.

R. C. P. Coggeshall, Albert S. Glover, Frank E. Hall, F. W. Shepperd, G. A. Stacy, and R. J. Thomas. — 6.

Members.

S. A. Agnew, W. G. Aubrey, M. N. Baker, H. K. Barrows, G. A. Bengamin, F. D. Berry, C. R. Bettes, Philander Betts, C. P. Birkinbine, F. E. Bisbee, A. E. Blackmer, J. W. Blackmer, C. M. Blair, Max Blatt, C. A. Bogardus, George Bowers, J. T. B. Bowles, C. F. Breitzke, A. W. F. Brown, W. W. Brush, James Burnie, L. W. Burt, C. J. Callahan, T. J. Carmody, Alvin Bugbee, S. K. Clapp, C. M. Clark, H. S. Clark, H. W. Clark, T. D. L. Coffin, W. R. Conard, J. E. Conley, J. H. Cook, H. R. Cooper, G. K. Crandall, H. C. Crowell, A. W. Cuddeback, John Cullen, F. A. Dallyn, L. B. Cummings, G. Gale Dixon, C. E. Davis, F. J. Davis, J. M. Diven, A. O. Doane, J. S. Dunwoody, E. R. Dyer, W. R. Edwards, C. H. Eglee, E. D. Eldredge, G. R. Ellis, A. B. Farnham, F. H. Fay, S. F. Ferguson, G. H. Finneran, A. D. Flinn, R. J. Flinn, A. P. Folwell, D. W. French, Halsey French, F. L. Fuller, W. E. Fuller, W. B. Fuller, W. S. Garde, Patrick Gear, T. C. Gleason, W. B. Goentner, H. J. Goodale, J. W. Graham, F. W. Greene, J. H. Gregory, C. A. Haskins, R. K. Hale, L. P. Hapgood, C. N. Harrub, L. M. Hastings, S. S. Hatch, W. C. Hawley, Allen Hazen, D. A. Heffernan, Clemens Herschel, A. B. Hill, N. S. Hill, Jr., Edgar Hodges, I. G. Hoagland, G. G. Honness, W. C. Hopper, D. J. Howell, A. C. Howes, E. W. Humphreys, J. L. Hyde, D. D. Jackson, C. E. Johnson G. A. Johnson, A. J. Jones, J. W. Kay, F. T. Kemble, Willard Kent, J. A. Kienle, S. E. Killam, F. C. Kimball, A. C. King, G. A. King, A. H. Kneen, Morris Knowles, C. F. Knowlton, J. W. Ledoux,

M. B. Litch, B. C. Little, F. F. Longley, J. B. Longley, F. H. Luce, P. J. Lucey, D. B. McCarthy, D. A. McCrudden, F. A. McInnes, S. H. McKenzie, T. H. McKenzie, W. A. McKenzie, Hugh McLean, H. B. Machen, H. V. Macksey, E. G. Manahan, A. E. Martin, T. P. Martin, W. B. R. Mason, John Mayo, F. E. Merrill, G. F. Merrill, Thaddeus Merriman, Leonard Metcalf, H. A. Miller, E. E. Minor, F. F. Moore, J. J. Moore, A. S. Negus, H. L. Newhall, G. I. Oakley, F. L. Northrop, Edward Neubling, C. L. Parmelee, E. L. Peene, T. A. Peirce, A. E. Pickup, W. D. Pollard, C. DuB. Pollock, Alexander Potter, E. A. Pratt, A. J. Provost, E. W. Quinn, J. F. Reagan, Jr., D. A. Reed, A. A. Reimer, J. H. Remick, W. H. Richards, T. F. Richardson, F. H. Robbins, L. C. Robinson, R. L. Sackett, F. D. Sayer, J. F. Sanborn, P. R. Sanders, W. J. Sando, C. M. Saville, W. P. Schwabe, J. E. Sheldon, C. W. Sherman, M. R. Sherrerd, H. H. Sinclair, M. A. Sinclair, E. F. Smith, G. Z. Smith, J. Waldo Smith, G. H. Snell, H. T. Sparks, W. E. Spear, F. N. Speller, G. T. Staples, R. H. Stearns, W. F. Sullivan, Russell Suter, Frank Talbott, H. A. Symonds, W. C. Tannatt, Jr., H. W. Taylor, S. F. Thomson, J. L. Tighe, R. K. Tomlin, Jr., J. A. Tilden, A. H. Tillson, D. N. Tower, L. L. Tribus, C. H. Tuttle, C. A. Van Keuren, William Volkhardt, Ernest Wadsworth, J. H. Walsh, G. L. Walters, F. D. West, William Wheeler, T. H. Wiggin, Wallace Willett, W. A. Wilcox, W. T. Wilson, F. J. Wise, I. S. Wood, L. P. Wood, L. C. Wright, W. H. Yates. — 209.

Associates.

Anderson & White, by C. H. White and L. P. Anderson; American Bitumastic Enamels Co., by W. A. Sealey, K. P. Ellis, O. L. Kearns; *American City*, by J. H. Van Buren and E. J. Burrenheim; Harold L. Bond & Co., by Harold L. Bond; William P. Brew; Builders Iron Foundry, by A. B. Coulters and E. H. Ford; A. M. Byers Co., by A. M. McCormick and G. F. Uhler; Central Foundry Co., by R. W. Conrow; Chapman Valve Manufacturing Co. (Ltd.), by J. T. Mulgrew, C. E. Pratt, T. F. Maher, and T. J. Gammon; Darling Pump & Manufacturing Co. (Ltd.), by H. A. Snyder, J. L. Hough, and H. D. Thorp; Joseph Dixon Crucible Co., by H. W. Chase and C. A. Williamson; H. W. Clark Co., by T. E. Irwin; Eddy Valve Co., by H. W. Dotton and H. A. Holmes; Electro Bleaching Gas Co.; by E. R. Glenn and E. D. Kingsley; *Engineering and Contracting*, by F. G. Hudson; *Engineering News*, by A. E. Kornfield, F. B. Godley, N. C. Rockwood; *Engineering Record*, by A. B. Gilbert, A. L. Sparks, I. S. Holbrook, and E. J. Mehren; *Fire and Water Engineering*, by Frederick Shepperd, F. W. Shepperd, and I. H. Case; Gamon Meter Co., by J. S. Eggert and H. D. Tate; Glauber Brass Manufacturing Co., J. F. Gibson; Hays Manufacturing Co., C. E. Mueller; Hersey Manufacturing Co., Albert S. Glover, W. C. Sherwood, W. A. Hersey, O. P. Hanks, H. A. Searles, J. Herman Smith, W. T. Hershaw, and J. A. Tilden; Kennedy Valve Co., H. M. Hein; Leadite Co., George McKay, Jr., and J. P. McKay; Lead Lined Iron Pipe Co., T. E. Dwyer and F. H. DuBois; Ludlow Valve Manufacturing Co., J. H. Caldwell and A. R. Taylor; Macbee

Cement Lined Pipe Co., J. H. MacBride; H. Mueller Manufacturing Co., F. B. Mueller, G. A. Caldwell, F. N. Fairfield, J. B. Clark; Multiplex Manufacturing Co., J. F. Casey; *Municipal Journal*, J. T. Norris; National Meter Co., J. G. Lufkin, H. L. Weston, W. P. Oliver, and J. H. Norris; National Water Main Cleaning Co., Clinton Inglee; Neptune Meter Co., R. D. Wertz, T. D. Faulks, and H. H. Kinsey; N. Y. Continental Jewell Filtration Co., E. K. Sorenson; Norwood Engineering Co., H. W. Hosford; Pitometer Co., E. D. Case and Jerome Powers; Pittsburgh Filter Manufacturing Co., F. B. Leopold; Pittsburgh Meter Co., J. W. Turner, V. E. Arnold, and R. W. Turner; Rensselaer Valve Manufacturing Co., F. S. Bates, J. S. Warde, Jr., and C. L. Brown; Ross Valve Manufacturing Co., William Ross; Sanitation Corporation, P. B. Streader; S. E. T. Valve & Hydrant Co., C. L. Lincoln; Simplex Valve and Meter Co., W. F. Harveson and J. A. Durst; A. P. Smith Manufacturing Co., F. L. Northrop, D. F. O'Brien, A. L. Wieman, T. F. Halpin; Standard Cast Iron Pipe & Foundry Co., W. F. Woodburn, W. P. Mosteller, and W. C. Hammond; W. P. Taylor Co., P. J. Wigel; Thomson Meter Co., S. D. Higley, C. D. Curnen, J. L. Atwell, F. W. Watson, E. M. Shedd, and W. S. Cetti; Union Water Meter Co., E. W. Jacobs, Edward Otis, and F. E. Hall; U. S. Cast Iron Pipe & Foundry Co., D. B. Stokes; Water Works Equipment Co., E. T. Scott, W. H. Van Winkle, and W. H. Van Winkle, Jr.; R. D. Wood & Co., H. M. Simons, C. R. Wood, and C. F. Baker; Henry R Worthington, W. F. Bird, F. J. Smith, Samuel Harrison, and H. F. Peake. — 118.

Guests.

Maine: Augusta, Wesley W. Albee, Miss Florence A. Hunton; Castine, Mrs. George A. Benjamin, P. E. Benjamin; Portland, W. D. Sears. *New Hampshire:* Concord, Mrs. H. L. Sanders. *Vermont:* Springfield, F. R. Lovell. *Massachusetts:* Arlington, Mrs. H. S. Clark, Mrs. J. E. Minor, Mr. and Mrs. Arthur H. Smith; Attleboro, Carrie L. Perry, Mrs. G. H. Snell; Boston, Mrs. George A. Caldwell, Z. W. Carter, Mrs. Albert S. Glover, Mrs. H. H. Kinsey, Mrs. S. E. Killam, James N. Mudge, Mrs. F. A. McInnes, Edward A. McLaughlin, Mrs. Edward E. Martin, Mr. C. F. Glavin, Miss J. M. Ham; Bridgewater, Mrs. John Mayo; Brookline, Mrs. C. H. Eglee; Cambridge, Edward A. Coumehan, Mrs. L. M. Hastings; Chicopee, Mrs. C. A. Bogardus; Cohasset, Mrs. D. B. Tower; Concord, Mrs. William Wheeler; Dedham, Miss Grace M. Staples; Easthampton, Mrs. W. C. Tannatt, Jr.; Fall River, Capt. F. S. Whiting; Haverhill, W. Arthur Teed; Holyoke, Mrs. Hugh McLean, Miss Maryon McLean, Mrs. T. J. Carmody, Mrs. R. J. Thomas, John E. Sullivan, David H. Sullivan, Mr. and Mrs. J. H. Carmichael, Katheryne Carmichael, J. W. Crawford, Helen E. Bowers; Marlborough, Mrs. George A. Stacy; Malden, John W. Murphy, John J. Connell; Medford, Henry T. Hughes; Melrose, Mrs. C. F. Knowlton; Millbrook, L. M. Peterson; Onset, Neddie Eldredge; Pittsfield, Mrs. F. J. Wise; Somerville, Mrs. Samuel Harrison, Mrs. Frank E. Merrill, Mr. and Mrs. D. L. Dow; Springfield, Mrs. L. E.

Herrick, Morton L. Miller; Wellesley, Mrs. F. L. Fuller; Westfield, Mrs. John L. Hyde; West Roxbury, Mrs. Richard J. Flinn; West Springfield, Mrs. J. Witperm, Mrs. A. Norris, B. E. Fox. *Rhode Island:* Narragansett Pier, Mrs. Willard Kent; Pawtucket, Miss F. Murray, Miss M. Murray, Mrs. C. Jetti; Providence, Mrs. Irving S. Wood. *Connecticut:* Ansonia, Thedore L. Bristol; Hartford, Mrs. L. W. Burt, John A. Collord, James J. Dennehy, F. S. Goodwin, R. J. Kinsella, Arthur J. McManus, Mrs. Caleb M. Saville, D. J. Sullivan, Charles L. Tuttle; Middletown, Mrs. G. Z. Smith; New London, H. S. Richards, Mrs. George K. Crandall; Southington, Miss Eunice J. McKenzie, Mrs. S. H. MacKenzie, Mrs. W. A. MacKenzie. *New York:* Amityville, Mrs. Clinton Inglee; Bay Ridge, Mrs. M. A. Golding, Mrs. H. J. McMahon; Bronx, Mr. and Mrs. A. A. McInnes, Mrs. H. Lester Newhall, Mrs. C. A. Williamson, A. Williamson; Brooklyn, Miss Mary S. Ambrose, Miss Madge G. Ambrose, Joseph Cochran, George P. Conard, Thomas F. Flinn, Frank G. Hale, Mrs. E. W. Jacobs, Miss M. E. Jacobs, Carlos Lobo, John P. Mern, Mrs. F. W. Shepperd, Mrs. H. Searles, Miss T. May, Mrs. W. W. Brush; Dobbs Ferry, Mrs. W. E. Fuller; Far Rockaway, Dr. M. M. Slocum, Mrs. M. M. Slocum, Mr. and Mrs. S. N. Durland, Mrs. Charles R. Bettes; Grand View on Hudson, Mrs. Alexander Potter, Miss Harriet F. Dangerfield; Hudson Falls, Mrs. W. G. Aubrey; Hawthorne, Mrs. Fred F. Moore; Jamaica, Geraldine White, Mrs. Elizabeth White; Johnstown, Mrs. Edgar Hodges; Mt. Vernon, H. G. Havill; New York, Eliot N. Smith, Mrs. E. T. Barclay, Albert R. N. Aherns, May I. Agnew, Rudolph C. Becker, Henry C. Bunche, William R. Billings, T. Hugh Boorman, Mrs. Mildred Clark, W. S. Coulter, R. W. Creuzbaur, H. W. Chase, Hon. Charles N. Chadwick, Eugene A. Dummer, Mrs. Thomas Farmer, Jr., Mrs. Arthur L. Fletcher, John T. Fetherston, O. B. Gunther, Martin Gleason, Miss F. E. Gray, R. H. Gaines, Mrs. W. B. Goenther, William Hanck, T. Hochlerner, Mrs. G. P. Harvey, Frank E. Hale, Edward Hatch, Jr., Nathan C. Johnson, Ernst Jonson, Mr. and Mrs. Walter Krider, Jacob Klein, William Lenihan, Hon. John Purroy Mitchel, Mary W. McDonough, John McDonough, Mrs. H. B. Machen, John F. Mead, Thomas McGowan, James McDonough, Thomas McManus, Mr. and Mrs. F. McAvoy, Eugene C. Miles, Mr. Charles G. Massa, Fred B. Nelson, Miss Eva Richtmyer, Thomas Ryan, Julian Richmond, Mrs. Everett Richtmyer, Harold C. Stevens, Dr. W. J. O'Sullivan, Jas. R. Smith, Jos. Sweeney, Mrs. Louis L. Tribus, Mrs. James H. Van Buren, Mrs. W. H. Van Winkle, Mrs. Wilbur T. Wilson, Mrs. C. Willson, Edward L. Walker, H. B. Woods, Louis Weiler, Hon. Delos F. Wilcox, A. Wilson, Thomas White, M. E. Zipser; Rosebank, Miss Charlotte Dougherty; Richmond Hill, Mrs. E. K. Sorenson; Stapleton, Mr. A. N. Volkhardt, Mrs. William Volkhardt, Miss M. N. Volkhardt; Saratoga Springs, Albert E. Kay; Tompkinsville, E. H. Hopson; Troy, Mrs. Fred S. Bates, Mrs. J. M. Diven; Tonawonda, Miss M. R. Engelking; Utica, F. O. Larmon; Valhalla, Wilson Fitch Smith; Waterloo, Howard C. Kinney; Woodhaven, Mrs. F. H. Luce; Whitestone, Harry J. Bunche; White Plains, William J. Lyon; Yonkers, Mrs. Alfred D.

Flinn, Mrs E. L. Peene, Mr. and Mrs. J. C. Ryan, Chas. E. Wells, Mrs. T. Callan, Miss E. Redmond, Mrs. C. S. Daly. *New Jersey:* Atlantic City, L. Van Gilder, B. F. Souder; Bound Brook, Mrs. W. B. R. Mason; Bridgewater, Timothy Woodruff; Camden, Frank S. Fithran, James H. Long; East Orange; Mrs. A. A. Reimer, Mrs. William D. Agnew, W. D. Agnew; Jersey City, Samuel R. Wilson, F. La Tourtette, W. M. Hendrick, Steven Baken; Little Falls, Miss L. Cunningham; Montclair, Mrs. John H. Gregory; Newark, Mrs. T. D. Faulk, Mrs. W. H. Van Winkle, Jr., Mrs. Edward Maher, Mrs. T. F. Halpin; Passaic, Mrs. John H. Cook, C. A. Terhune; Paterson, H. M. Van Buren, Peter J. Nestler; Perth Amboy, Thomas Grieve; Rahway, Albert F. Kirstein; Riverton, Mr. and Mrs. W. H. Buck; Summit, William J. McWane, Mrs. F. C. Kimball; Trenton, R. A. Speck, Chas. H. Spreck, W. J. Stewart, Alonzo P. Buck, Mrs. Alvin Bugbee; Westfield, Mrs. E. D. Case, Mrs. A. Mallefert. *Pennsylvania:* Bloomsburg, H. C. Casey; Harrisburg, Ralph H. Hosmer; Johnstown, C. O. Johnston; Lansford, T. D. Lewis; Philadelphia, Mrs. D. A. McCrudden, M. Y. Neely, Marvin Y. Neely; Pottsville, Miss Mary S. Pollard; Torresdale, Mrs. Francis D. West. *Virginia:* Danville, Frank Talbott, Jr.; Newport News, W. B. Livezey; Petersburg, P. G. Bunting. *District of Columbia:* Washington, B. L. Howell, E. D. Anderson. *Indiana:* Indianapolis, Joel W. Hadley. *Minnesota:* Duluth, Mrs. D. A. Reed. *Ontario:* Carleton Pease, B. G. Michel.— 266.

Summary of Attendance.

Honorary Members	6
Members	209
Associates	118
Guests	266
	599
Names counted twice	5
Total attendance	594

Morning Session, Tuesday, September 7, 1915.

[Present, 150.]

The convention was called to order at 10.30 A.M. by President Leonard Metcalf, who said:

Ladies and Gentlemen, — It gives me great pleasure to welcome you here to-day to the thirty-fourth annual convention of the New England Water Works Association.

We had hoped to have with us this morning the Mayor of the city, Mr. Mitchel. Whether life at the Plattsburg training camp has been too strenuous for him or not I do not know, but he unfortunately was unable to come in person. He has, however, sent his representative in the person of Commissioner Woods who will address you.

Mr. Mitchel, who had served the city first as Commissioner of Accounts, and then as president of the Board of Aldermen, came into office about two years ago, and I am told, by those who are in a position to judge of the matter, that he has taken a very active interest in the water-works problem of this city, being perhaps more familiar than any other man, outside of those actively interested in the conduct of that work, in following up the details of construction and the administrative problems which have come up in connection with it. He also has been familiar with the Croton and Ridgeway supplies and with the other systems hereabout, and has come very closely in contact with those works.

I take great pleasure in introducing to you Commissioner Woods.

Police Commissioner Woods. *Mr. President and Ladies and Gentlemen,* — After the very appreciative words spoken by Mr. Metcalf about the Mayor's interest, his unusual interest, in the water works, I feel especially humble — even more so than a substitute usually does — in having to disappoint you by taking his place so far as I can this morning. I am not sure whether it was his experience at Plattsburg which incapacitated him or not. It may be that he picked me out because I have had about ten days in which to recover from my experience at Plattsburg. However, I rather suspect that what Commissioner Wilcox told

me a few minutes ago may be true, and that is that the Mayor was so invigorated and so reënforced by his month at Plattsburg that he felt even fit for the more strenuous task of beating down a budget of the Board of Water Supply for the year 1916 this morning.

As I understand it, this is the third time that the New England Water Works Association has met here in New York in ten years, and those ten years cover the growth of the tremendous project of bringing down water from the Catskills into New York City, a growth which has been accomplished under the unfaltering and very skillful supervision of Mr. Smith, who, as I understand it, is a past president of this Association. As it happens, I am freshly arrived from the Catskill region, having been climbing mountains up there for the last three days, and yesterday the trail led me down by the reservoir. I remember standing on a ledge some miles back from the head of the great dam, but about 2 500 ft. over it, and looking down on the whole area of this work, including a great part of the watershed itself, and I don't know when any one thing has impressed me more. One of the men with me had a government map of the district on which had been traced in blue ink the enormous lake which now lies there among those hills. These men knew that country when nothing but a mountain stream flowed down across the plateau, and from the ledge where we stood they had seen the great dam grow, and they pointed out to me the development of the work in vivid detail. And yet, as deeply impressed as I was, I could not help but think of it as a curious situation — this building of that enormous dam, a daring, brilliant scheme of transporting bodily the waters of the Catskills to us way down here — and still remembering, at the same time, that at the place where I spent the previous night, an old farmhouse made over into a summer boarding house, the family got their water from an old-fashioned pump from a hole in the ground alongside of the house. We pay a good many penalties for living together in the large communities which we call out cities, to-day, but there are also some benefits which we derive, to make up for the penalties, and I think one of them is the assurance of an adequate and pure water supply. People take it for granted that they are

going to get enough water, and wholesome water. They don't half stop to realize what might happen to this town if by any chance our water supply should become suddenly polluted so as to be unfit for use, or if it should be shut off. I think one reason why the Mayor was so eager to welcome you in person, and so disappointed that he could not do it, and why he charged me to get up here on time and to express his great regrets, was because he has taken more than a routine interest in this water-supply project. He, personally, has worked during these last few years not merely to help along the Catskill project, but also to make more efficient the present supply of water for New York City. And I feel that he has realized all along the way in which you gentlemen and this Association could bring home to the people the absolute need of an adequate and pure water-works system to the city.

My personal job with the police force has nothing to do with keeping the water works pure. It probably has more to do with regulating other liquid supplies which find their way into the city. Not so much with water! However, it does have to do with guarding the water supply. In times of serious trouble — disturbance, riot — we should be responsible for keeping the great reservoir and distributing system intact, so that the water could continue to flow through it. And it is a meeting such as this, of men who stand at the head of their profession in the water-works line, that should bring home to the people of the city the fact that they cannot take their water supply as something for granted, — that it must be the result of continued watchfulness, continued care, and of the continued employment of the services of the men who make it a profession and who are fitted to take care of it.

Therefore, in behalf of his Honor, I bid you welcome to New York. And in my own official capacity I want to assure you that although the lid is on, the town will be open cordially to you. And if anything needs attention in those lines, if you will let me know it shall be attended to. Thank you very much.

President Metcalf. We are fortunate in having with us to-day another gentleman who has played a very active part in the development of the new city supply of New York, Mr. Charles

N. Chadwick. His first interest in the problem dates back to 1897, when, as chairman of the Committee on Water of the Manufacturers' Association of Brooklyn, he with his associates presented a report on the New York water supply, which was the beginning, the inception of the work which is now nearing completion. From that time to the appointment of the Board of Water Supply he and the Manufacturers' Association worked with other civic bodies for the inauguration of this great water supply project and to have it put upon the right basis. He was the first man appointed by Mayor McClellan to take up this great work, and for upwards of ten years has been perhaps the most active member of the board upon it. Mr. Chadwick has always had in mind three central ideals, I understand, in connection with this project: the first, that by constitutional amendment expenditures for the water supply should be without the city's debt limit; the second, that the commission should have a continued existence and be free from politics in the ordinary and objectionable use of that word; third, that the scheme to be adopted should contemplate a long period — that is, should look forward to a period of perhaps fifty years from its inception. Mayor McClellan in an address at the turning of the first sod for the beginning of the aqueduct's construction referred to the part played by the various civic bodies in the following words:

"Nor could we have aroused public opinion without the help of the public-spirited civic organizations, first and foremost among which was the Manufacturers' Association of Brooklyn, under the insistent, consistent, and persistent direction of our commissioner, Mr. Chadwick."

I take pleasure in introducing to you Mr. Chadwick.

HON. CHARLES N. CHADWICK. *Mr. President, Ladies and Gentlemen,* — It is a pleasure and a privilege for me, as one of its commissioners, to be here and welcome you to the activities of the Board of Water Supply. I welcome you to its detailed work.

Back up in the Catskill mountains, millions of years ago, if our geologists tell us aright, was a lake. In due course of time the geological action of that great ice mound that rested upon the continent wore down the lower side of that lake. It was this

site that our engineers discovered, and around the lower edge of it they have built a dike six miles along, and across the Esopus which sometimes we can cross without wetting our feet and which at other times is a roaring torrent thirty or forty feet deep, they have built a dam, and enclosed in there a body of water which holds 132 billion gallons, enough to cover the entire island of Manhattan twenty-eight feet in depth. To that work in its physical aspects as you will see it now, I welcome you. If you should go up there and embark upon our launch and sail over that lake twelve miles long and in its widest part three miles wide, you could in your imagination see underneath that water 7 villages, 3 000 people that were alive, 32 cemeteries, 2 800 dead bodies, a railroad 14 miles long, churches, schools, and all the activities of human life, all removed and taken away, and in their place a great body of water, — the Ashokan Reservoir.

And I welcome you to the work of the builders of the Catskill aqueduct. Following along the 120 miles of the aqueduct from the Ashokan Reservoir to Silver Lake Reservoir in Staten Island, a great tunnel winds its way down across the valleys, and underneath them, and through the mountains until you come to the Hudson River. And there at Storm King it goes down 1 200 ft. below the surface of the water and crosses 3 000 ft. and comes up at Breakneck 1 200 ft. to the surface of the water, and 400 ft. more, or in all 1 600 ft., to the gradient line, — and on down toward the city.

And, again, I welcome you to the work being done at Kensico, near Valhalla, to that great dam that is thrown across what was once Kensico Reservoir, to back the water up into Rye Pond, and hold there in storage a supply sufficient for the city for fifty days, if for any reason there should be a lack of supply of water from the Ashokan Reservoir. And then you come to the equalizing reservoir at Yonkers. And then you can follow the subterranean journey of 18 miles below the level of the streets of New York through the pressure tunnel under the Island of Manhattan, through a tunnel diminishing from 15 ft. in diameter to 11 ft. until it crosses the East River at Manhattan Bridge, at a depth of 750 ft. below the surface to Brooklyn, and then through Brooklyn, through pipe lines, out into Queens, and then

on down to the Narrows, where we are building a 3-ft. pipe line across, and on to Silver Lake Reservoir, at Staten Island, which is the last and smallest of the reservoirs that is being built.

To these and other details of this work that is being done by the city of New York through the Board of Water Supply, I welcome you.

I also welcome you to the offices of the Board of Water Supply on the twenty-second floor of the Municipal Building; for you know this work is divided into two great departments, the administrative and the engineering. In the administrative department we have such divisions as those relating to the acquisition of land, payment of damages, purchasing of supplies, then also on questions of law, questions of legislation, and, the controlling factor, our auditor's department in charge of the finances of the Board.

Now, I do not ordinarily when I am speaking read, but I want to read to you what I asked our auditor to prepare, which will show you just exactly how the work in that department is conducted, for it is the keynote and the control of our work, and through it and by means of it we know exactly what we are doing every day in the year and practically every minute in the day. In making his report to me he writes:

"The financial operations of the Board of Water Supply are conducted along the same lines as a banking institution or a large corporation. It knows at the end of each day the total amount of its resources, the total amount of disbursements, and the purposes for which the same have been made and the amount of its liabilities. The Board therefore knows daily to what extent it may embark upon new enterprises in completing the work in hand. At each weekly meeting of the Board there is presented a statement setting forth the exact financial condition of the Board at the close of the preceding day. This statement is printed in the record of the Board's proceedings. The accounts of the Board show the cost of acquiring land pursuant to condemnation proceedings, in great detail. It is the first time in the history of the City of New York that information along these lines has been compiled. The figures disclosed have an important bearing on the question of revising the method of acquiring land for the city, which will eventually result in saving hundreds of thousands of dollars in interest and other costs incidental to acqui-

sition. Quarterly and annual statements are prepared which show the functional cost of construction over the entire line of work in great detail. When the work of construction is finished it will be possible to determine the cost of construction per foot of the various types of aqueduct."

Back ten years ago, when the question came up how we should organize our bookkeeping department, it was determined then and there that we should organize it along lines of positive knowledge. If mistakes were ever made — and they are likely to be made — they should show for all time, and we should have a system of bookkeeping of such a kind that at any moment, at any time, for any reason, the exact cost of any particular work should be known. I welcome you to that and the other activities of the headquarters department in the City of New York.

Your chairman has very pleasantly alluded to some of the work I have been engaged in in the past, and it leads me to say this, that in the beginning, when this work was first taken up in 1897 by the civic bodies of the Greater New York, it was realized that a work of this magnitude must be handled on business principles, through a non-partisan board, independent of politics. It was so conceived, it was so planned, it has been so worked out and carried on. And the result is that we have been able to go on and do our work with great freedom, with great regularity, with great speed and economy, and within the estimated time, and, as I believe, within our estimated cost as laid down at the time when we made our map plan and estimate of cost back in 1905. For at that time we asked for $161 000 000, to which was to be added later the cost of the pressure tunnel under the Island of Manhattan, making a total of $177 000 000. Of that sum, $127-000 000 has been expended in cash, and we have a sufficient balance on hand to our credit to go on and do the work.

In modern cities throughout the country the effort is making toward a business administration, and it was this conception that the Board of Water Supply had; that the City of New York had; and that the legislature of the state of New York had at that time — through the influence of the civic bodies — that this work from beginning to end should be conducted along business lines. I want to place the emphasis upon that in order that you

may understand why it is that we have been able to accomplish what we have.

Now, in all great constructive works there is not much difference as to the engineering control, as to the business administration, and the work finally is done and finished. But here New York City has adopted a plan of work which is unique and which takes into consideration another element besides that of administration, business, and engineering, and that is the human element. Working under an eight-hour law, the leisure time was the problem. We were pretty sure of the laborer's time and employment, because when he was asleep he *was* asleep and when he was working the engineers controlled him; but it was the eight hours of leisure, the time which was on his hands and might hang heavily and would be open to mischief, which we took into consideration, as to what we should do in order that we might get one hundred per cent. of efficiency out of an eight-hour day. And so it was that in drawing up our contracts we wrote into them specifications which provided for the intelligent housing of the workingmen, for the sanitary control of the camps, for the incineration of garbage, and so on, — for commissaries, hospitals, surgeons, and all the things that go to make life endurable in these far-away places where men are gathered together to do special work. That was all right as far as it went. Then the legislature passed an act creating a board of police which was to control and protect the inhabitants against these laborers and people who were coming in there and working and might make trouble. In fact, we reached at one time a maximum, I believe, of about 25 000 of one kind and another employed upon this work during the period of heavy construction. That again was all right. Then on top of that and in addition to that, in order to develop an *esprit de corps*, arrangements were made for clubs for our engineers and, growing out of that as the solution of the problem, CAMP SCHOOLS for the workingmen, to teach them the English language, in order that the element of misunderstanding by lack of a common medium of expression should be removed, so that the contractor and laborer could get along and understand each other without the intervention of the middleman. In addition to that, a study of the laws and institutions

of the country, and the rights of persons and property, put these foreigners that came to us — Slavs, Italians, and other nationalities — into an intelligent comprehension of our point of view. On the other hand, we tried to arrive at an intelligent comprehension of their point of view from our side. And so it has been that in the ten years that I have been commissioner and that this work has been going on, the problem has been solved and we have had no strike.

Now, back in 1832, De Witt Clinton planned the Croton watershed. That was followed by the Ridgewood watershed of Brooklyn. And after that the department of water supply carried on the work. Then in 1905 came the time when this work was to be taken up. And we are to add to the water which the city now has, about 500 000 000 gal. a day, another 500 000 000 gal. a day. The first installment of 250 000 000 gal. that the reservoirs and aqueduct now completed are ready to deliver will be ready at the end of next year, 1916; and a few years later, upon the completion of work going on in the Schoharie and elsewhere for the second installment of 250 000 000 gal., the entire work will be completed on time. Ten years ago we submitted a map and plan and estimate of cost to the Board of Estimate and Apportionment, stating that it would take twenty years to do the entire work. The indications are that, having completed and ready for delivery next year the first installment, the second installment will follow well within the estimated time.

And now, lastly and in conclusion, water is the great asset of the city of New York. The work that began with De Witt Clinton and continued with others is now being carried on by the Board of Water Supply. It is the great asset of the city of New York, for without water what could you do? President Eliot, in an address he made some years ago, speaking of the fundamental needs of a great city, said that they are light, air, and water, — and the greatest of these is water.

Gentlemen, to this work I welcome you, — to this great asset of the city of New York I welcome you. And I want to say to you that in the work that has been done — and I say it because I know — it has been honestly done, and when that cup of pure and wholesome water has been brought from the Catskill moun-

tains to the outreaching hand of the people of the city of New York, it will be given to them with a clean hand.

PRESIDENT METCALF. Amongst the other municipal activities of a great city such as this, is the problem of the relation of the public-service corporations to the city. Mr. Delos F. Wilcox has played an active part in these, first as the chief of the Bureau of Franchises of the Public Service Commission of the First District, from 1907, shortly after the commission was established, until 1913, when he proved himself an able champion of the cause of the people; and later, in his employment by the Water Department to take charge of the valuation of certain private water companies, still operating in New York City and vicinity, for the purpose of advising the commission as to the fixing of rates and for negotiating possible terms of purchase; and subsequently, when he was appointed deputy commissioner of this department. I take pleasure in presenting to you Mr. Wilcox.

HON. DELOS F. WILCOX. *Mr. President, Ladies and Gentlemen,* — You have been welcomed to great things, and it falls to my lot, as the representative of Commissioner Williams, who is spending the last day of a two-weeks vacation out of the city, to welcome you to our troubles.

The Department of Water Supply, Gas and Electricity is charged with the care, protection, maintenance, and operation of the portion of the water supply that is in actual operation at the present time; with the collection of the water revenues; with the high pressure fire service; with the inspection of water meters; and, in addition to that, has charge of the lighting of 2 600 miles of streets and 2 300 public buildings, and of all electrical inspection in the buildings of Greater New York. I will not refer to these other and additional functions because they are of no particular interest to you as members of a water-works association.

One of the very serious problems that we have in this city is that of getting enough revenue to run our business. We have an income of only about $13 000 000 a year from the sale of water; we need more. As soon as the Board of Water Supply, the agency for constructing the new Catskill aqueduct, turns over to us the first installment of the Catskill supply, with the burden of paying

the interest on its cost, we shall have to find $8 000 000 a year in order to pay merely the interest and sinking fund charges on that debt. We have the problem of discarding, or putting into reserve, a water supply from the ground which we now have to pump — the Brooklyn supply — amounting to about 150 000 000 gal. per day. We have to carry the investment that has already been put into the development of that watershed. You can readily see that either the city of New York has got to increase in population, or the department has got to be more diligent in the collection of revenues, or we have got to raise the rates, or do something in order to meet these great obligations which are coming upon us.

In that connection, the first problem that faces us, of course, is the problem of economy of administration, and just at the present time I wish to congratulate you that you have come this year and this month when we still have an adequate force of engineers who can welcome you to our works, because the budget makers are after us, and perhaps, if you were to come next year, nobody could spend even ten minutes to come here to say "how-do-you-do" to the Water Works Association. When Mr. Hill's organization, the American Water Works Association, comes, next year, we shall probably see that this will be proven.

The next problem is that of increasing our gross receipts. Now, we have a somewhat antiquated and very complex system in New York. Under the charter enacted by the legislature, the commissioner is authorized to require meters to be installed in tenement houses, apartment houses, and other buildings used for residence purposes. Under that authorization the commissioner has extended the meter system to practically all business premises, so that we now have about 100 000 meter accounts. But the Board of Aldermen, being not unnaturally responsive to the wishes of its constituents, has not yet given its consent to the installation of meters in residence premises. We therefore have about 250 000 accounts on frontage and fixture rates. Actual investigation of our rates, which have come down to us in large measure from the first half of the last century, will convince any one, I think, that they are antiquated, inequitable, and need to be revised. We have under our charter, however,

the requirement that if meters are installed they must be installed and maintained at the expense of the property owner. We feel somewhat open-minded on that question, and that is one of the questions in the solution of which we welcome your assistance. But we are inclined to think that the proper method of running a water department, as also of running a public-service corporation, is for the department to install at public expense, and maintain at public expense, the meters which are a part of the machinery for the collection of the water revenue. If we go to that policy we shall, of course, have to spend more money both for the installation of the meters and for their maintenance thereafter, and we shall therefore require still more revenue; and one of the problems we are studying now is as to how far the extension of the meter system to all residence premises throughout the city would reduce our expenses by curtailing the consumption of water, and how far it would increase our revenues by getting us a revenue for all the water consumed.

We are confronted with another problem in connection with the rates, which is not, perhaps, entirely peculiar to New York, but which represents a condition that is far from what it ought to be. No account has ever been made in the water-works accounts of the cost of fire protection, and therefore the city of New York has pursued the policy of furnishing fire protection by means of the larger mains, the greater pressure, the hydrants, and the separate high-pressure system, all as a part of the expense of operating the Water Department, for which the department has received no compensation directly through appropriations. We also have a very liberal exemption list. Charitable institutions as well as all city buildings have their water free. Our water rates are treated as a tax, and practically all institutions which are exempt from taxation are exempt from water rates.

In this connection we have a still further complication, one that is giving us a good deal of trouble now. In the outlying portions of the city — Brooklyn and Queens — there still exist private water companies, and although they seem relatively small and unimportant as compared with the city of New York and its municipal water works, still they serve a population of approximately 400 000 people. Now, they are not subject to

the Public Service Commission, and with one exception they have no exclusive franchises, so that the city of New York, with its municipal water works, enjoys the right to supply these same people with municipal water. In four or five cases the rates are in certain respects different from and higher than the rates charged by the city. These companies have their plants, which have been built up while they served suburban communities, partly while these communities were outside the city limits. We have chosen to go to the Catskills for our great water supply. When we get it we shall discard our own Brooklyn supply, temporarily at least. And the question is, What is to become of the property and business of these private water companies which are operating in the city, which the city ought to acquire but for which it cannot possibly afford to pay an exorbitant price, especially since it has secured for the future a water supply elsewhere? We have to run a little miniature public-service commission in our department because under the charter, by a rather vague section but very general and inclusive, the commissioner is given jurisdiction as to the quality and quantity of the supply and as to the charges and regulations of the various private water companies operating within the city, and therefore we have this very unusual situation, where a department which is a potential competitor is, under the statute, the only public authority which is vested with the right to regulate the rates and practices of the companies with which it might possibly compete. You can imagine that, with the president of the American Water Works Association representing one of the companies, we are well put to it to see that justice is done but that the city does not get the bad end of the bargain.

Perhaps I might add one thing further in regard to the relation of the city to private water companies. Naturally, the problem of determining what the city shall pay for fire protection in the private water company territory is an interesting and complex one because in the nature of the case the city must pay something for this service, although on its own works it makes the consumer pay for it. In these parts, at least, there has been very little scientific investigation and determination of the actual minimum cost of fire service as compared with the cost of domestic service.

And while the city in the past, I fear, has been too rich to be economical, we are coming to a stage in our indebtedness and in the burdens that are upon us where there is danger of our becoming too poor to be honest. Between these two conditions you can see that it puts the administrators of the Water Department, who are attempting to be just and efficient, in a position where they cannot take very long vacations.

In conclusion, a question that I would like to put up to you is this: Do you think that the effluent of a modern sewage-disposal plant is good to drink; is it proper for the state of New York to put into the water supply of New York City the effluent of a modern sewage disposal plant? That is a live question just now, and if you gentlemen can give us an answer that will be effective either to stop the state from doing so, or to satisfy the people of New York that the effluent of a sewage plant is good to drink, we shall be greatly obliged to you.*

I thank you, gentlemen.

President Metcalf. We are fortunate in having with us to-day Mr. Nicholas S. Hill, formerly chief engineer of the Department of Water Supply, some ten years or more ago, who during his term of office did, as many of you will recollect, a very noteworthy work in the detection of water waste in this city and in the study of that general problem of the waste in the use of water, and in the reorganization of the records of his department. Since then he has been actively engaged in private practice. To-day he comes to welcome us as president of a sister organization, the American Water Works Association.

I take pleasure in introducing to you Mr. Nicholas S. Hill.

Mr. Nicholas S. Hill. *Mr. President, Fellow Members of the New England Water Works Association,* — Mr. Metcalf has relieved me greatly because I have been sitting thinking upon what score I would welcome you. Mr. Chadwick welcomes you to his million-dollar schemes of various kinds, with his reservoirs, aqueducts, pipe lines. Commissioner Wilcox welcomes you to the various activities of the Department of Water Supply.

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*The Governor of the state of New York has decided to heed the protest of the city and see that other provision is made for the disposal of the sewage effluent than the one contemplated when this address was presented. — D. F. W.

The only thing that I really know that I can do is to welcome you as a fellow member of the New England Water Works Association who is in deep sympathy with the work which you are doing and who appreciates the aims and objects of this Association.

As president of the American Water Works Association I hardly feel justified in welcoming you, because I think that the average member of the New England Water Works Association would say that that Association has just as much claim in New York as the American Water Works Association. I hope some time, however, and I believe the time will come, when there will not be an American Water Works Association and a New England Water Works Association, but there will be one grand, big association of all the water-works interests of the United States, in which every man who has the common interest and the common cause of the water-works profession in his heart will unite for the benefit of that profession. I live in the hope of seeing that day, and I shall never rest comfortably until that day is at hand.

Now, gentlemen, I am sure that every one in the city of New York will welcome you. I can welcome you as a New Yorker, as an individual. I can welcome you as an engineer located in New York, as a member of the local profession. I am sure every one here will welcome you, will be glad to see you. We shall be glad to see you in our office. I am sure you will find every office in New York open to you, and you will find that the average New York business man is not so busy that he has not the time always to welcome those whom he is glad to see.

President Metcalf in response to the addresses of welcome spoke as follows:

As the representative of this organization, it gives me pleasure to acknowledge the friendly words of welcome which you gentlemen have brought to us. The casual visitor has long recognized New York as a most delightful place to visit, and for the past ten years the engineers of the country have recognized it as the busiest city in the country, one of the busiest cities in the world, in an engineering way. To the water-works men also it has been for the past ten years a Mecca. Work of tremendous interest has gone on here, involving all of the more important problems

incident to bringing into the city a new source of water supply, and many very novel problems have been met here in a very creditable way. The work reflects great credit not only upon its projectors but on its designers and builders, and there is good reason to hope that it will do so equally upon those in whose hands will rest the administration of the works hereafter. The city administration and the city administrators may well be proud of this great work and their connection with it. To those familiar with the *esprit de corps* which has been built up in the engineering force, which has had active charge of the conduct of this work, by Mr. J. Waldo Smith and his associates, there is great encouragement, for it seems to me that it has been shown here that a great American city can conduct its public works of such a nature not only in an efficient but in a highly economical manner. The problem has been studied with great thoroughness in advance of construction, and economy has been reflected as a result of this, in the actual building of the works.

Gentlemen, I congratulate you upon the fruition of your efforts, the planning, the financing, and the building of these great works.

This organization is an organization of water-works men, largely water-works superintendents. It is run by water-works men, for the best interests of water-works construction in this country. And it is perhaps not unnatural that we in New England, and members of this organization particularly, the New England Water Works Association, should feel some sense of pride in the influence which that organization has exercised in the raising of standards of construction in the water-works field; for if you will look down the roster of the engineers and the water-works men in the different branches of the service in your city, I think you will be struck by the fact that many of the men had been previously trained in New England. Consider, for instance, the part played by some of the consulting engineers to your works. First, Mr. Kirkwood's name occurs to me; Mr. Cheseborough, Mr. Fetley, Mr. Davis, Mr. Herschel, Mr. Stearns, Mr. Freeman, Mr. Hazen, Mr. Fuller, Mr. Whipple, Mr. Jackson, and others. And on the active staff, J. Waldo Smith, chief engineer, and Mr. Alfred D. Flinn, his able deputy; Carleton E.

Davis, one of the division engineers now running the Water Department of Philadelphia; Mr. Winsor, recently called to Providence; Spear, Wells, Wiggin, Moore, Wheeler, and many more whom I might mention, going down the line. It seems to me, gentlemen, that that is of great significance to all of us, because it means practically that in the water-works field we are in this country getting good, efficient administration, progressive development; men are being advanced from the work in the small communities to that of the larger communities, and finally to the works of the largest cities in the country. The influence is very far reaching, the importance of the study, the careful, intelligent study, of such a large work as this work here is tremendous in the development of first-class standards of practice. In spite of all that has been said of German efficiency and the efficiency in the handling of municipal work across the water, I believe it is an absolute fact in the water-works field, amongst the superintendents and engineers alike, you find in this country a genuinely cordial spirit, a spirit of coöperation, which is unparalleled the world over — and I have had opportunity to judge somewhat of the conditions on the Continent and in Great Britain. I believe it is due in no small measure to the activities of such societies as these, — the New England Water Works Association, the American Water Works Association, the American Society of Civil Engineers, and others. It is earnestly to be hoped that this spirit of coöperation may continue to the advantage of the work, of the public, and of the water-works men themselves.

To the visitors to this convention I would say, — you are most welcome. We hope that you will find in the proceedings of this convention matters which may be of interest to you and which may lead to your taking an active part in its affairs. All that we desire is to make the society of the greatest possible service to the men working in this field of activity.

To the members I want to express the hope that while this convention is in session you will work together and play together, and that the distractions of this great city may not serve to lead you astray.

It is with deep regret that I have to bring to your attention at this time the loss of one of our foremost and ablest members,

a man who had served us in the capacity of president of this organization, who had done a very active work upon a number of its committees, who had devoted himself largely during his lifetime to the betterment of the standards of water-works practice and in working for this society, a man who was much beloved and greatly honored by all of you, I know. I refer, of course, to Dexter Brackett, chief engineer of the Metropolitan Water Works, Boston, who recently died.

In conclusion I wish to express my personal obligation to the members of the Committee on Arrangements, for the work they have done in the preparation for this convention. Work of that sort is most exacting. Things do not take care of themselves; they have to be thought of beforehand and the necessary arrangements made. Unfortunately, in this respect, I chanced to have been on the Pacific Coast since early in May, and it was not possible for me to take the active part which I should otherwise have hoped to have done in that period. But I am sure that nothing will be lost to you in this convention as a result of my absence, for the committee has been most active. And I hope that when the convention is over you will be able to say that it has lived up to the high standard of the conventions of this Association.

I want to say just a word in recognition of the work of the *Engineering Record* in getting out this water-works daily, which it has so kindly prepared for you. It seems to me that it is a welcome and valuable innovation in our convention activities.

Our appreciation is also due to the courteous work of the *Engineering News*, which presents to the membership with its compliments this pamphlet upon the water works and other engineering features of New York City, which I feel sure you will all be interested in glancing over.

I am glad to be able to announce that we have twenty-nine additional applications for membership, which, with the added number of members who have come to us from the American Water Works Association, brings our membership up to somewhere about 965, and with a little greater effort, gentlemen, we should be able to pass the one thousand mark this year, and so increase the capacity for service of this Association.

In passing, I call attention to certain papers which have been omitted from the program, or, rather, which came too late for announcement. The first is a paper on the " Sanitation of a Large Watershed," by Mr. George G. Honness, department engineer of the Board of Water Supply, which will be presented after Mr. Smith's talk upon the Catskill water supply; the second, on " Wire Fences with Concrete Posts," by Ralph N. Wheeler, department engineeer of the Board; " Forestration of Watersheds, Detail Methods," by Sidney K. Clapp, assistant engineer of the Board of Water Supply; and finally, " Grubbing a Large Reservoir," by George A. Winsor, section engineer of the Board of Water Supply.

The Secretary read the following names of applicants for membership, all of which had been properly endorsed and approved by the Executive Committee:

Active: Jesse F. Barrett, of Peabody, Mass., water department; James R. McClintock, of Plainfield, N. J., engineer and sanitary expert; Charles M. Clark, of New York, aqueduct commissioner of the Board of Water Supply; R. L. Dobbin, of Peterborough, Ont., superintendent; G. Gale Dixon, of Kent, Ohio, engaged on the barge canal, Catskill Aqueduct, and improved water works for Akron, Ohio; W. H. Dittoe, of Columbus, Ohio, engaged in sanitary engineering as chief engineer of the Ohio State Board of Health; J. S. Dunwoody, of Erie, Pa., in charge of water sterilization plant, Erie, Pa.; Louis A. Fournier, of San Jose, Costa Rica, C. A., assistant engineer Pacific Railroad, 1910–1911, member Inst. Eng. Congress of California, 1915; James F. Hayden, of Brooklyn, N. Y., inspecting hydrants, valves, pipes, etc., used as water conveyors; Edgar Hodges, of Johnstown, N. Y., superintendent of water works; Charles D. Howard, of Concord, N. H., in charge of public water-supply inspection; Edmund A. Pratt, of New York City, civil engineer; H. W. Parkinson, of Rockhampton, Queensland, Rockhampton water works; James D. Stover, of Dallas, Tex., now secretary of water department, Dallas; Arthur Surveyer, of Montreal, Canada, general consulting practice; John A. Switzer, of Knoxville, Tenn., L. H. Van Buskerk, of Columbus, Ohio, assistant sanitary engineer of the Ohio State Board of Health, now director of the division of laboratories; M. L. Worrell, Meridian, Miss., water works, meter reading to management, twenty-nine years; W. H. Yates, of New York City,

consulting engineer; Nisbet Wingfield, of Augusta, Ga., general municipal work, construction, and operation. — 20.

Associate: Ralph L. Shainwald, Jr., waterproofing design and general engineering; H. W. Clark, manufacturer water-works appliances; Pittsburg Filter Manufacturing Company, of Pittsburg, Pa., filter manufacturing and construction; Sanitation Corporation of New York; Wallace & Tiernan Company, Inc., of New York; Merritt & Chapman Derrick and Wrecking Co. of New York; Anderson & White, of New York; American Cast-Iron Pipe Co., Birmingham, Ala., manufacturers of cast-iron water and gas pipes; *Engineering and Contracting*, Dearborn Street, Chicago. — 9.

On motion, the Secretary was empowered to cast the ballot of the Association in favor of the candidates, and he having done so they were declared by the President duly elected members of the Association.

On motion of Mr. C. E. Davis, it was voted that the President be authorized to appoint a nominating committee of five members to nominate officers for the ensuing year. The President subsequently appointed as members of the committee the following gentlemen: F. A. McInnes, E. W. Kent, J. Waldo Smith, E. E. Lockridge, A. E. Blackmer.

President Metcalf. If there is no further business to come before the meeting we will listen to the first address of the convention, which is upon "The Present Status of the Catskill Water Supply for New York City." Mr. J. Waldo Smith is too well known and beloved by the membership of this Association to require introduction by me.

Mr. J. Waldo Smith then addressed the convention on "The Present Status of the Catskill Water Supply for New York City," with stereopticon illustrations.

Mr. George G. Honness, department engineer of the Board of Water Supply, followed with a paper on "Sanitary Improvement of a Large Watershed," after which the Association adjourned till two o'clock P.M.

Afternoon Session, September 7, 1915

[Present, 107.]

The afternoon session opened with a paper by Mr. Henry A. Symonds, consulting engineer with Hanscom Construction Company, Boston, on " Leadite Joints for Water Pipes," this paper being immediately followed by the paper of Mr. W. C. Hawley, chief engineer and superintendent, Pennsylvania Water Company, Wilkinsburgh, Pa., on " Leadite as a Material for Joints." The subject treated in the two papers was discussed by the following gentlemen: Mr. J. M. Diven, Troy, N. Y.; Mr. Frank L. Fuller, Boston, Mass.; Mr. D. A. McCrudden, Philadelphia, Pa.; Mr. George H. Finneran, Boston, Mass.; Mr. George F. Merrill, Greenfield, Mass.; and Mr. A. E. Martin, Springfield, Mass.

The next paper on the program was entitled, " Laying Water Pipe in Congested Streets in New York City," by M. Platt, assistant engineer, Department of Water Supply, Gas and Electricity, New York, N. Y., which was discussed by Mr. J. M. Diven, of Troy, N. Y., and President Metcalf. The paper was illustrated by stereopticon slides.

In the absence of Mr. E. G. Hooper, his paper on " Location of Leaks in Submarine Pipe Lines " was read by Mr. F. B. Nelson, assistant engineer, Department of Water Supply, Gas and Electricity, New York.

" Tests of Leakage from Lead Joints " was the subject of a paper by Arthur H. Smith, engineer, Associated Factory Mutual Fire Insurance Companies, Boston, Mass. The paper was discussed by Mr. George H. Finneran, Boston, Mass.; Mr. Frank L. Fuller, Boston, Mass.; Mr. Walter E. Spear, New York, N. Y.; Mr. Henry A. Symonds, Boston, Mass.; Mr. Morris Knowles, Pittsburg, Pa.; Mr. Irving S. Wood, Providence, R. I.; Mr. A. E. Martin, Springfield, Mass.; Mr. George A. Stacy, Marlboro, Mass.; Mr. George F. Merrill, Greenfield, Mass.; Mr. Frank L. Fuller, Boston, Mass.; Mr. W. C. Hawley, Wilkinsburg, Pa.; Mr. Edward D. Eldredge, Onset, Mass.; Mr. William F. Sullivan, Nashua, N. H. Mr. Sullivan accompanied his remarks by a motion, which was duly adopted, that a committee be appointed to investigate experience in the leakage of pipe joints. The com-

mittee which was later appointed by the President was made up as follows: F. A. Barbour, chairman; C. E. Davis, S. E. Killam, C. M. Saville, H. B. Machen, and A. H. Smith.

The discussion of this paper concluded the afternoon session.

Evening Session, September 7, 1915.

[Present, 88.]

The evening session was opened by Mr. Harry W. Clark, who read a paper on "Double Sand Filtration of Water, at South Norwalk, Conn.," the paper being accompanied by stereopticon views. The discussion following the paper was participated in by Mr. J. S. Dunwoody, of Erie, Pa.; Mr. Allen Hazen, of New York; Mr. S. S. Hatch, of South Norwalk, Conn.; Mr. Daniel D. Jackson, of New York; Mr. L. M. Hastings, Cambridge, Mass.; Mr. J. M. Diven, Troy, N. Y.; Mr. A. E. Martin, Springfield, Mass.

The next paper of the evening was by Francis F. Longley, consulting engineer, New York, on "Salem and Beverly Water Supply," this paper also being accompanied by stereopticon views, and being discussed by Mr. L. M. Hastings, of Cambridge, Mass.; Mr. J. M. Diven, of Troy, N. Y.; Mr. D. W. French, of Weehawken, N. J.; Mr. James W. Blackmer, of Beverly, Mass.; Mr. Morris Knowles, of Pittsburg, Pa.

The session adjourned to 9.30 A.M., Wednesday, September 8, 1915.

Morning Session, Wednesday, September 8, 1915.

[Present, 105.]

As the first item of business, the Secretary presented a supplementary list of applications for membership, endorsed and approved by the Executive Committee, as follows:

Active: E. E. Miller, Palisade, N. J., engaged in designing and testing engines, and assistant superintendent power plant of Hackensack Water Company; William J. O'Sullivan, M.D., of New York, practicing physician and counsel in litigations involving problems in sanitation; J. Bosley Thomas, Baltimore, Md., in charge of the laboratories of the Baltimore City Water

Department and assisting in operation; Harold C. Stevens, Sea Cliff, N. Y., civil and hydraulic engineering; Wesley W. Albee, Augusta, Me., superintendent and engineer, Augusta Water District; Arthur H. Smith, Arlington Heights, Mass., engineer Factory Mutual Fire Insurance Companies; Edward W. Henry, Jersey City, N. J., superintendent of meter department, Jersey City Water Works; George I. Oakley, Little Falls, N. Y., city engineer; B. G. Michel, Carleton Place, Ont., Canada, municipal engineer; Alvin Bugbee, Trenton, N. J., engineer of Water Department; George F. Catlett, chemist, Board of Health, Wilmington, N. C. — 11.

On motion duly made and seconded, the Secretary was empowered to cast the ballot for these members, and upon his doing so they were declared by the President duly elected members of the Association.

Mr. Charles W. Sherman. Mr. President, in the intervals between sessions I have been again and again spoken to by different members about Mr. Dexter Brackett. The general feeling of regret at his loss is so marked, and especially the regret that the Association has not honored Mr. Brackett as it would have liked to do could it have foreseen what was coming, has been expressed so strongly, that it has occurred to a few of us that possibly something special might be done that would keep his memory green before us, and of such a nature as would be pleasing to Mr. Brackett himself, could he know of it. I don't think we want to take any ill-considered or hasty action on a thing of this sort, but it has occurred to me that the question of a memorial be referred to the committee on memoir which you are about to appoint, asking them to report at a subsequent meeting what, after due consideration and inquiry among the members, seems to them the most desirable form. As a mere suggestion, it has occurred to a few of us that possibly a memorial fund might be raised by subscription, the income to be used annually either for a prize for a paper of a certain character, for committee research, or for otherwise advancing the business of the Association, which Mr. Brackett had so deeply at heart. As I see it at the moment, it appears to me that, if such a fund were established, its general principles might be stated in the constitution of the fund, and the precise application for each particular year be left to the

Executive Committee for that year. Perhaps for one year it might be used to advance certain committee work, for another year it might be used as a prize for a paper, and in other years it might take still other forms. On the other hand, it might be specifically set aside for a prize or medal to be awarded year after year. I offer a motion that the committee on memoir to Mr. Brackett be requested to consider the desirability of a suitable memorial fund.

Mr. Frank C. Kimball. In rising to second that motion I would like to say that those of us who have had more or less to do with Mr. Brackett, who have known of his active interest in this Association, and who know his work, his love, if you please, for the Association, feel that nothing could be more fitting, nothing would please him better, if he were in a position to choose for himself, than to have something of this kind carried on by the Association to perpetuate his name; and I think that the thing for the Association to do is to adopt some memorial of this kind with his name attached, so that his memory will remain with us. I second the motion.

President Metcalf. It is moved and seconded, then, that the memorial committee, to be appointed by the President, give consideration to the question of a suitable memorial to Mr. Brackett, — bearing in mind the suggestions made by Mr. Sherman as to the form which it might take, — and that the committee report at a later meeting to this Association.

(The motion was adopted, and the President appointed as the committee Mr. Frederick P. Stearns, Mr. Alfred D. Flinn, and Mr. Allen Hazen.)

President Metcalf. I have also to announce, and do so with great pleasure, that the Executive Committee suggests to your favorable consideration the election to honorary membership of three men, very active members of this Association, all of them past presidents of the Association, all of them having established reputations for sound management of the water works of which they have had charge. I refer to Mr. Edwin C. Brooks, who became a member of this Association on February 10, 1897, and served as president in the year 1904; who was first engineer at one of the stations of the Cambridge plant, I believe, and

thereafter superintendent of those works, and who made a very good record for himself in their administration. He is now retired and living in Melrose. I had hoped he might be here at this convention but is not.

The second is Mr. George A. Stacy, superintendent of the Marlboro Water Works, who became a member on April 21, 1888, and who served as president in the years 1894 to 1895. He has also served as vice-president and member of the executive committee for many years. He has played a very active part in the councils of this Association.

The third member, Mr. Robert J. Thomas, became a member of the Association in June, 1892, and served as president at the time of the last convention which was held in this city, in the year 1909. He has served also as the president of the American Water Works Association and, as you all know, has been very active in the work of this Association, having for years played a very active part upon the Fire Protection Committee, whose work resulted in the development, perhaps, of the Hersey detector meter, and devices of that sort. He served also as advertising agent of the Association from 1901 to 1908, and again from 1910 to 1911, and has taken, as you all know, a very active part in the work of the Association. He has been superintendent of the Lowell Water Works since 1887, with the exception of three years when the political wheel of fortune turned him out.

The Chair will be very glad to entertain any motion in regard to this recommendation of the Executive Committee.

Mr. J. M. Diven, of Troy, N. Y., moved that the recommendation of the Executive Committee be adopted and that the Secretary cast the ballot of the Association for the gentlemen named, and the motion being duly seconded was adopted, and the Secretary cast the ballot as directed, the gentlemen being declared elected honorary members of the Association.

President Metcalf. If there is no further business to come before the convention we will proceed to the first paper of the morning, upon "Reasons for Adopting Solid Wedge Type of Valve in Boston." Before opening the discussion the Chair would like to suggest to the convention the query whether it might not be of advantage to us in a matter of this sort to open

the floor to the associate members, who might be able to contribute to the discussion upon this subject. It seems to me that the subject is a broad one and one upon which we should be glad to have the manufacturers' point of view as well as the point of view of the user of the valves. Does the convention care to take any action along this line?

Mr. J. M. Diven. I move that the manufacturers, or representatives of manufacturers, of valves be accorded the privilege of the floor for the discussion of this paper. I am not sure, in making this motion, whether it is in conflict with the constitution or not.

President Metcalf. The Chair would rule that it is not in conflict with the constitution — certainly not with the spirit of the constitution — for, after all, in a matter of this sort, all that we wish to do is to get at the truth, and any light which can be shed upon the question we wish to have.

It is moved and seconded that the discussion of these papers upon the subject of the relative desirability or advantages and disadvantages of the solid wedge type of gate or the disk type of gate, be opened to the associate members.

The motion was adopted.

Mr. George H. Finneran, assistant superintendent, water service, Boston, Mass., then read the first paper of the morning, "Reasons for Adopting Solid Wedge Type of Valve in Boston." Discussion of the subject was postponed until after the reading of the paper entitled, "Reasons for Using the Double Disk Type of Valve," by John M. Diven, superintendent of water works, Troy, N. Y. The discussion of the subject included, in addition to the authors of the papers, remarks by Mr. Frank L. Fuller, of Boston, Mass.; Mr. A. O. Doane, of Boston, Mass.; Mr. Morris Knowles, of Pittsburg, Pa.; Mr. W. C. Hawley, of Wilkinsburg, Pa.; Mr. John H. Gregory, of New York, N. Y.; Mr. Frank C. Kimball, of Summit, N. J.; Mr. Robert J. Thomas, of Lowell, Mass.; Mr. W. C. Tannatt, Jr., of Easthampton, Mass.; Mr. D. A. McCrudden, of Philadelphia, Pa.; Mr. Frank L. Fuller, of Boston, Mass.; and Mr. Caldwell, a representative of one of the associate members; Mr. Patrick Gear, of Holyoke, Mass.; Mr. A. E. Martin, of Springfield, Mass.

The next paper of the morning was by F. B. Nelson, assistant engineer, Department of Water Supply, Gas and Electricity, New York, Mr. Nelson's subject being "Testing Meters with Reference to Curves of Accuracy and Friction Loss." The paper was discussed by Mr. Caleb M. Saville, Hartford, Conn.

The next paper in order was read by Mr. Alfred Williamson, mechanical engineer, Department of Water Supply, Gas and Electricity, New York, being entitled, "Electrically Operated Valve Installations and Their Control from a Distance," the paper being illustrated by stereopticon views. Mr. William F. Sullivan, of Nashua, N. H., discussed the paper.

Mr. James F. Sanborn, of New York, next read a paper by Mr. Ralph N. Wheeler, department engineer of the Board of Water Supply, New York, entitled, "Wire Fences and Concrete Posts," which closed the morning session.

Evening Session, September 8, 1915.

[Present, 120.]

The first paper of the evening, by Mr. H. D. Havill, assistant engineer, Department of Water Supply, Gas and Electricity, New York, was entitled, "Pump-Slip Tests as an Aid to Efficiency in the Operation of Pumping Engines."

Mr. Wilson Fitch Smith, division engineer, Board of Water Supply, New York, then read a paper, illustrated by numerous stereopticon slides, on "The Kensico Reservoir of the New York Water Supply."

The next paper of the evening, entitled, "Decolorization of Water by Storage," was by Ralph H. Stearns, civil engineer, Boston, and was followed by discussion on the part of the following gentlemen: Messrs. Alexander Potter, New York; Edward D. Eldredge, Onset, Mass.; Allen Hazen, New York; Daniel D. Jackson, New York; W. C. Tannatt, Jr., Easthampton, Mass., and a written communication by Mr. Robert S. Weston, of Boston.

The next paper was a paper by Mr. T. C. Culyer, assistant engineer, Department of Water Supply, Gas and Electricity, New York, entitled, "Costs and Results Obtained in Reforestation of the Croton Watershed." Another paper on the same subject was contributed by Sidney K. Clapp, assistant engineer

of the Board of Water Supply, the paper being entitled, "Forestation of Watersheds, Detail Methods." The subject of the two papers was discussed by Mr. Caleb M. Saville, of Hartford, Conn.; Mr. Edward E. Minor, New Haven, Conn.; Mr. William F. Sullivan, Nashua, N. H.; Mr. Wilson F. Smith, New York.

The final paper of the evening was contributed by Mr. W. F. Laase, being entitled, "Infiltration Galleries as a Source of Water Supply on Long Island." The paper was discussed by Alexander Potter, of New York, and Walter E. Spear, of New York, after which the session adjourned.

Morning Session, Thursday, September 9, 1915.

[Present, 60.]

As the first business of the morning the Secretary read the following names of additional applicants for membership:

Active: L. Van Gilder, Atlantic City, N. J., engineer and superintendent of water department; John W. Murphy, Malden, Mass., in charge of the meter system; B. F. Sonder, Atlantic City, N. J., of the water department. — 3.

On motion of Mr. J. M. Diven, Mr. R. C. P. Coggeshall was empowered to cast the ballot of the Association in favor of the candidates, and, he having done so, they were declared by the President duly elected members of the Association.

The President announced that the number of active members in attendance at the convention had reached 578.

Mr. Charles W. Sherman. Mr. President, On behalf of the Committee of Arrangements of this excursion I want to offer the following vote:

"That the thanks of the Association be extended to his Honor Mayor Mitchel, Police Commissioner Woods, Board of Water Supply Commissioner Chadwick, and Deputy Commissioner Wilcox of the Department of Water Supply, Gas and Electricity; to *Engineering News* for its book on the water works, and to *Engineering Record* for its daily convention record; to the gentlemen not members of the Association who have presented papers and taken part in the discussions; and to the Water Works Manufacturers' Association and the other associates and members whose generous contributions to the entertainment fund have made possible the entertainment features of this convention."

In presenting this motion I want also to say a word which I did not see how to incorporate properly in the motion, but which I think ought to be brought to the attention of the convention, relative to the manner in which the entertainment and exhibition features of the convention have been handled this year, — somewhat different from anything we have done before. Hitherto we have depended entirely on our own committees to administer the exhibits, and on voluntary contributions solicited from members and associates for the entertainment fund. This year we entered into a coöperative arrangement with the Water Works Manufacturers' Association, as a trial on both sides, — not putting the thing actually in charge of the Manufacturers, but accepting a contribution from them with the understanding that none of their members should make any further contribution to the entertainment fund, and appointing an Exhibit Committee, from our own members, to be sure, but practically a Manufacturers' Association Committee, to look out for the exhibits. From all the comments that I have heard, and from the experience of the Committee of Arrangements, this seems to have worked out to the entire satisfaction of all concerned. And I want to express the appreciation of the Committee of Arrangements for the cordial coöperation of the Manufacturers' Association, not only in their contributions, but in making the arrangements and in working out the convention.

The motion, being duly seconded, was adopted.

The first paper of the morning was read by Mr. Russell Suter, assistant civil engineer, Conservation Commission, Albany, N. Y., and was entitled, "Control of Public Water Supplies by the Conservation Commission of the State of New York." The paper was discussed by Mr. J. M. Diven, of Troy, N. Y.; Mr. Morris Knowles, of Pittsburg, Pa.; Mr. G. L. Waters.

The next paper of the morning, by Harold K. Barrows, of Boston, Mass., was entitled, "Improvements to the Fall River Water Supply," and was illustrated by numerous stereopticon views. The paper was discussed by Mr. Frank L. Fuller, of Boston, and Mr. Percy R. Sanders, of Concord, N. H.

On motion of Mr. Frank L. Fuller, the convention adjourned.

EXECUTIVE COMMITTEE.

Meeting of the Executive Committee, Wednesday, April 7, at 11 A.M.

Present: President Leonard Metcalf, and members Edwin C. Brooks, Samuel E. Killam, Willard Kent, Richard K. Hale, Lewis M. Bancroft, and George A. King.

Voted, on motion of Mr. King, seconded by Mr. Bancroft, that the June Excursion be a trip down the harbor.

Voted, that the President be and hereby is authorized to appoint a committee on the June Excursion.

Adjourned.

Attest: WILLARD KENT, *Secretary.*

Meeting of the Executive Committee of the New England Water Works Association on steamer *Mayflower*, Boston Harbor, Wednesday, June 16, 1915.

Present: James Burnie, George F. Merrill, Charles W. Sherman, William F. Sullivan, Lewis M. Bancroft, George A. King, and Willard Kent.

Eighty-two applicants for membership were received, and the applicants were by unanimous vote recommended therefor.

Two (2) applicants — one active and one associate — were reinstated to membership, they having complied with the requirements of the Constitution.

Adjourned.

Attest: WILLARD KENT, *Secretary.*

Meeting of the Executive Committee of the New England Water Works Association at Hotel Waldorf-Astoria, New York, Tuesday, September 7, 1915, at 9.30 A.M.

Present: President Leonard Metcalf, and members James Burnie, Carleton E. Davis, George F. Merrill, Charles W. Sherman, William F. Sullivan, Samuel E. Killam, Richard K. Hale, George A. King, and Willard Kent.

Twenty-nine applications for membership and nine for associates were presented, and it was unanimously voted to recommend these applicants for membership.

A communication from Mr. Alfred D. Flinn, written and received prior to the death of Mr. Dexter Brackett, recommending that Mr. Brackett, for his efficient work in behalf of the New England Water Works Association, be made an honorary member thereof, was presented.

Regret was expressed that on account of his death this action was impossible, and the recommendation made that some suitable action be taken by the Association in honor of his memory.

A communication from Mr. F. H. Newell, secretary of Committee on Engineering Coöperation, asking the concurrence of the Association, was read and, after discussion, Messrs. Carleton E. Davis, William F. Sullivan, and George W. Batchelder were constituted a committee on the subject.

Adjourned.

Attest: Willard Kent, *Secretary.*

Meeting of the Executive Committee of the New England Water Works Association at Hotel Waldorf-Astoria, New York, Wednesday, September 8, 1915, at 9.30 A.M.

Present: President Leonard Metcalf, and members James Burnie, Carleton E. Davis, George F. Merrill, Charles W. Sherman, William F. Sullivan, Samuel E. Killam, Richard K. Hale, George A. King, Caleb M. Saville, and Willard Kent.

Eleven applications for membership were presented, and they were by unanimous vote recommended therefor.

Adjourned.

Attest: Willard Kent, *Secretary.*

Meeting of the Executive Committee of the New England Water Works Association at Hotel Waldorf-Astoria, New York, Thursday, September 9, 1915, at 9.30 A.M.

Present: President Leonard Metcalf, and members James Burnie, Carleton E. Davis, George F. Merrill, Charles W. Sherman, William F. Sullivan, Samuel E. Killam, Richard K. Hale, George A. King, Caleb M. Saville, and Willard Kent.

Three applications for membership were presented, and they were by unanimous vote recommended therefor.

Adjourned.

Attest: WILLARD KENT, *Secretary*.

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New England Water Works Association.

ORGANIZED 1882.

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THE PRESENT STATUS OF THE CATSKILL WATER SUPPLY FOR NEW YORK CITY.

BY J. WALDO SMITH, CHIEF ENGINEER, BOARD OF WATER SUPPLY, NEW YORK CITY.

[*Read September 7, 1915.*]

Ten years ago it was my privilege to welcome the members of this Association to New York as they gathered for their annual convention some three months after the organization of the Board of Water Supply, when the engineering force numbered only twenty-five. Since that time the work has progressed to a maximum where the yearly expenditure was twenty-six million dollars, with an engineering force of about 1 320, and the time is now near when the city can utilize this great improvement. The maximum expended in any one month was \$3 900 000, and the maximum amount earned on any one contract in a month was \$473 000. The maximum amount earned on all contracts in a single year was \$19 500 000, and there have been six years when the earnings were in excess of \$10 000 000. The total expenditures to date are \$127 300 000, and obligations undertaken and nearly completed for \$8 300 000, or a total of \$135 600 000. No contract in a total of \$99 965 000 has been relet, and, so far as I can learn, no surety company has been called on to advance money. In order to furnish necessary data for the location of structures and the preparation of contracts, forty-six miles in depth of borings were made. The first construction contract for eleven miles of aqueduct was ready to advertise in October, 1906.

The present status of the work is:

The construction work of the Ashokan Reservoir is substantially completed, and there remain only grading and grassing, some highway and bridge work, the superstructures of the gate chambers and the aëration basin to be done. Water has been stored in the West Basin since September, 1913, and in the East Basin for about one year. Much water has been wasted during

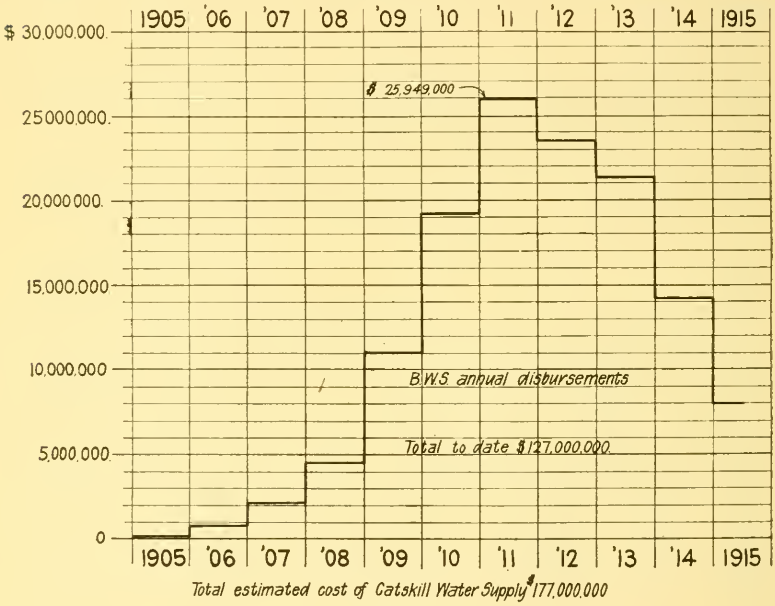


FIG. 1.

Diagram of the annual expenditures to date of the Board of Water Supply.

this year and there is still in store about 80 billion gallons of a total of 128 billion gallons. This reservoir will furnish a daily supply of not less than 250 million gallons, and investigations are now under way for other reservoirs to increase the capacity to not less than 600 million gallons per day. The capacity of this reservoir is over 20 per cent. greater than that of all the reservoirs in the Croton watershed. The construction work on the aqueduct, 92 miles long, will be completed in October, and more

Fig. 1.

The site of the Ashokan Dam as it existed ten years ago, the location of the dam being at the left of the picture, around the bend.

Fig. 2.

The Ashokan Dam as it exists to-day. This picture is taken very nearly from the same point as Fig. 1.

than half of it has been carefully tested. Recent hydraulic experiments have disclosed that its capacity, making a reasonable allowance for loss due to growths which may accumulate in years of use, is about 600 million gallons per day. Recent measurements of leakage of two of the principal pressure tunnels, the Rondout and Wallkill, each $4\frac{1}{2}$ miles long, showed for the Rondout, with 230 ft. unbalanced head or outward pressure, 70 gal. per minute, and for the Wallkill, with 150 ft. outward pressure, 32 gal. per minute. A preliminary test of $3\frac{1}{2}$ miles of the city

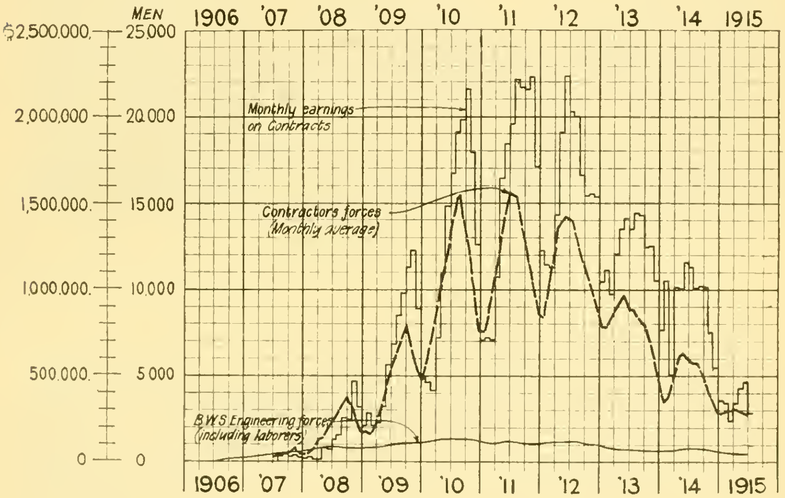


Fig. 2.

This diagram shows the maximum monthly earnings by contractors, reaching the maximum of about \$2 200 000 in 1911; the contractors' working force, reaching a maximum of about 17 000; and the engineering force, at the bottom, which reaches a maximum of about 1 325.

pressure tunnel between 93d Street and 25th Street, with 250 ft. outward pressure, showed a leakage of 90 gal. per minute, and if this follows the example of the other similar tunnels, will show a substantial reduction with time.

Construction work of the Kensico Reservoir will be so far completed at the end of the year that it may be entirely filled about four years ahead of the contract time.

The construction work of Hill View Reservoir, a small equalizing reservoir at the entrance of the city pressure tunnel, will be completed in October. The construction work of the city pressure tunnel, 18.1 miles long, the longest tunnel in the world, and varying in finished diameter from 15 to 11 ft., is nearing completion. The tunnel proper is completed, with the exception of tests. There remains, however, much detailed work in and at the top of shafts connecting it with the distribution system. The submerged pipe line across the Narrows promises completion by the end of the year, and the reservoir on Staten Island is in an advanced stage of construction.

For the 6.3 miles of steel pipe siphon, only one pipe has been laid; the other two will be added when the reservoir capacity is increased. Studies for a filtration plant are now under way, but, if built, this cannot be completed before 1920.

Since the Association met here in 1905, the work has progressed without misadventure or serious accident, so it is confidently expected that by January 1, 1916, it will be in the condition of a very large machine with very many working parts, which have just been assembled for the first time, and which has not been adjusted or tested. Some of the parts of the machine are necessarily of new and untried design to satisfy conditions never before met. And the problem that will then confront us on January 1, 1916, is the adjustment and test of this machine, the smoothing of the gears and bearings, the replacement or modification of the parts which do not properly perform their functions, the training of the operating force, the thorough adjustment and trial of the entire plant, and the tuning up and synchronizing of all the working parts, to the end that the operation may be safe, smooth, and continuous. It is believed that this may require all of the year 1916, although undoubtedly at times water from the Catskills will be delivered into the distribution system.

When it is considered that a considerable part of the total supply will be delivered directly into the pipes without any intervening reservoir and that a pumped supply of about 200 million gallons daily will be discontinued and the men laid off, it will be realized that everything in connection with the gravity supply

Fig. 1.
One of the bridges, this particular one being the Traver Hollow Bridge on Ashokan Reservoir road system.

Fig. 2.
Another bridge carrying a state highway across the Kensico Reservoir.

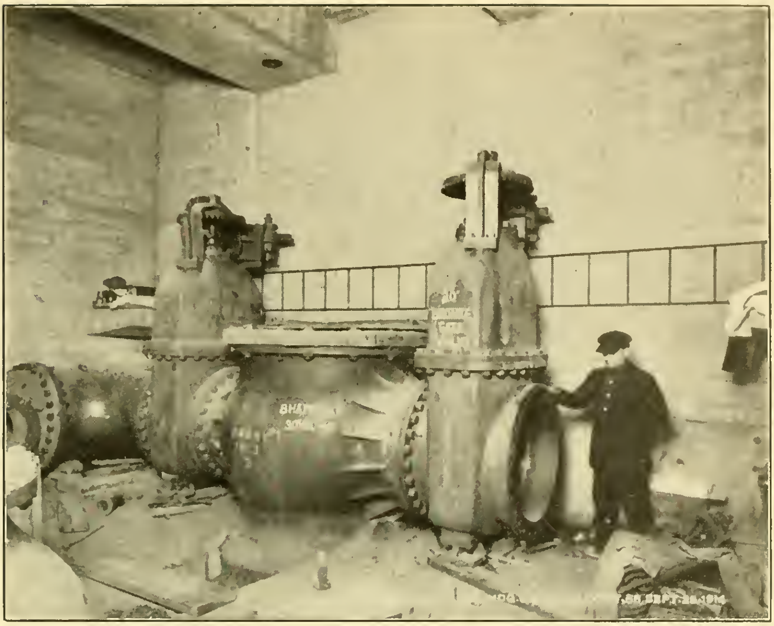


FIG. 1. This picture shows one of the risers which comes up through a shaft of the city tunnel, the view being of the inside of one of the chambers. The shaft cap and valves on either side are of solid bronze, and the cap is riveted directly to the riser pipe which comes up the shaft. On either side connections will be made to the distribution system.

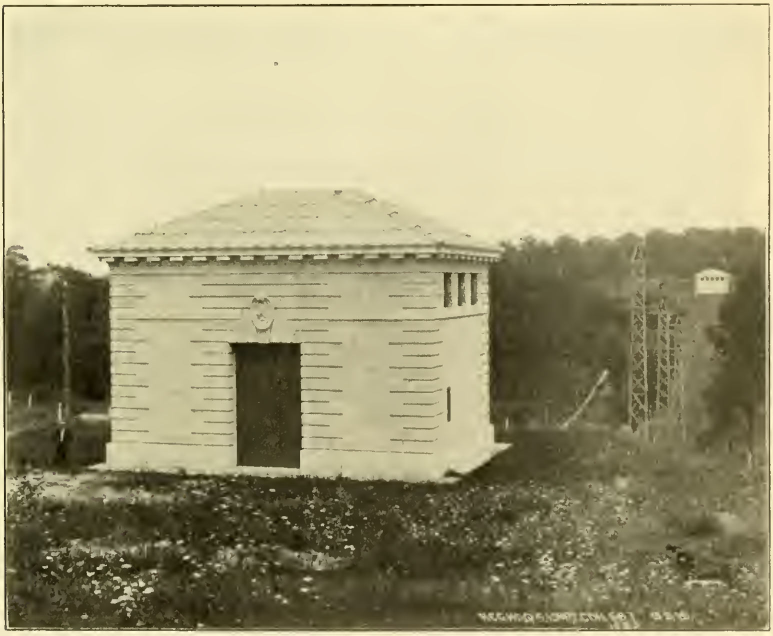


FIG. 2. A completed siphon chamber. There is such a chamber at each end of each steel pipe siphon. In the distance you see the downstream chamber for the same siphon.

must be made as perfect and safe as possible, and that the estimated time of a year is none too long.

When the work is so far completed that water can safely and continuously be delivered to the distribution system, the maintenance and operation of that portion will devolve on and be directed by the Department of Water Supply.

KENSICO RESERVOIR.

BY WILSON FITCH SMITH, DIVISION ENGINEER, BOARD OF WATER SUPPLY, NEW YORK CITY.

[*Read September 8, 1915.*]

The Kensico Reservoir is an important feature of the Catskill Aqueduct project. It is located in the upper valley of the Bronx River in Westchester County, about three miles north of White Plains, and will form a storage reservoir comparatively near the city for the Catskill water collected in the impounding reservoirs, of which the Ashokan is the first to be constructed.

Kensico Reservoir is formed by Kensico Dam. The storage behind Kensico Dam will cover 2 218 acres at Elev. 355 above mean sea level, with a maximum depth of 155 ft., an average depth of 53 ft., and an available capacity of 29 000 000 000 gal. This will afford a large reserve storage near the city, only fourteen miles above the distributing reservoir at Hill View just north of the city line, and will make possible the closing down for inspection and repair if necessary the seventy-five miles of aqueduct between Kensico and Ashokan. As the city already maintained a reservoir at this point, it owned 1 300 acres, including the Rye Ponds, and about 3 200 acres of additional land were acquired for the purpose of the new reservoir. The old reservoir supplied a portion of the Bronx Borough with about 18 000 000 gal. a day through a 48-in. cast-iron pipe line, and as the selected site for the new dam was about 400 ft. above the old dam, it was necessary to provide a substitute supply during the construction of the new dam. Therefore, the first work was the construction of the temporary reservoir further up in the Bronx Valley, and the pipe line connecting it with the Bronx conduit.

The Catskill Aqueduct, with a maximum daily capacity of 500 000 000 gal., will discharge into the upper end of Kensico Reservoir four miles north of the dam over a weir 216 ft. long in the side of the aqueduct. The hydraulic grade line of the aque-

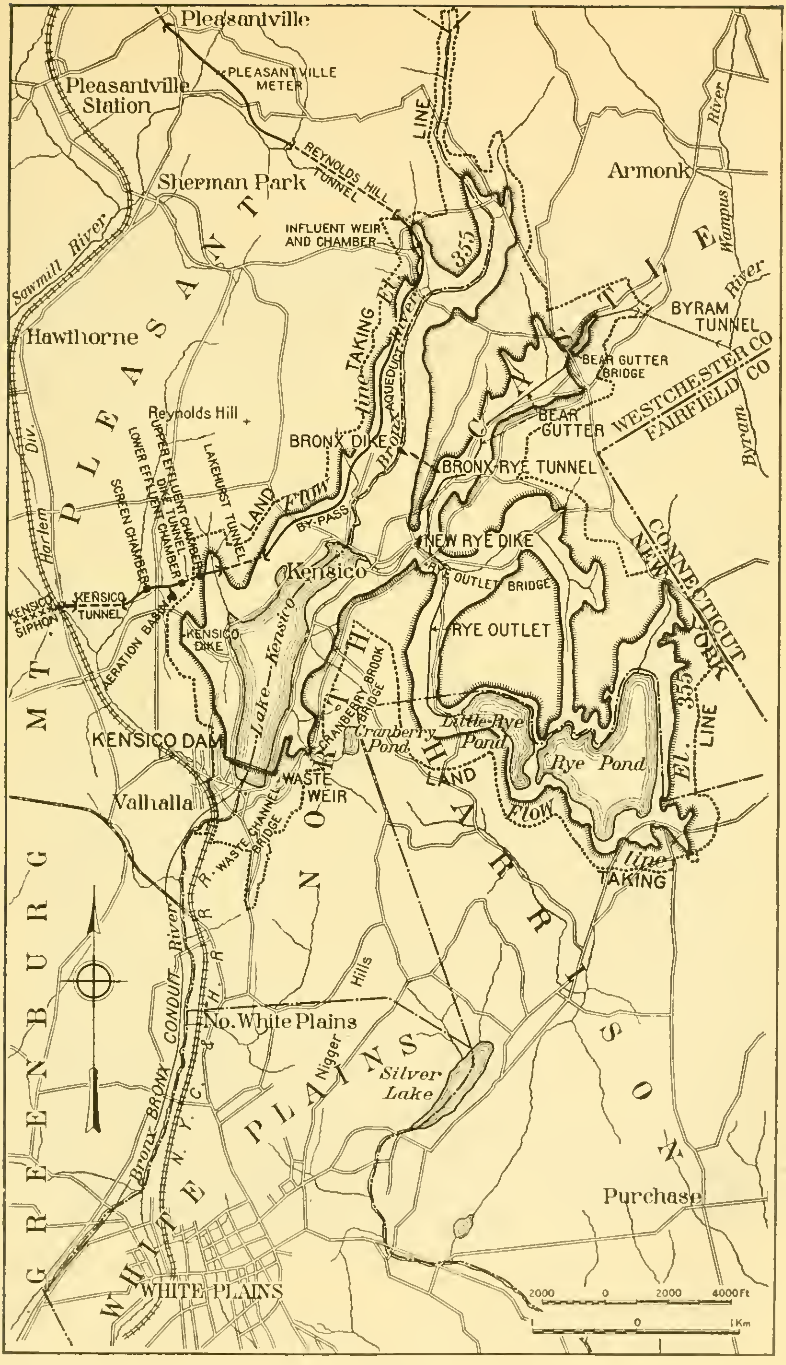

Pleasantville
PLEASANTVILLE METER
Pleasantville Station
REYNOLDS HILL TUNNEL
Sherman Park
Armonk
INFLUENT WEIR AND CHAMBER
LINE
355
Sawmill River
River
Wampus
Hawthorne
BYRAM TUNNEL
BEAR GUTTER BRIDGE
WESTCHESTER CO
FAIRFIELD CO
BEAR GUTTER
Byram
Reynolds Hill
BRONX DIKE
TAKING
line
Flow
LAND
Bronx River
AQUEDUCT
BRONX-RYE TUNNEL
UPPER EFFLUENT CHAMBER
DIKE TUNNEL
LOWER EFFLUENT CHAMBER
SCREEN CHAMBER
LAKEHURST TUNNEL
BY-PASS
NEW RYE DIKE
CONNECTICUT
NEW YORK
Harlem Div.
Kensico
RYE OUTLET BRIDGE
KENSICO SIPHON
KENSICO TUNNEL
AERATION BASIN
KENSICO DIKE
Lake Kensico
RYE OUTLET
BROOK BRIDGE
CRANBERRY BRIDGE
Cranberry Pond
Little Rye Pond
Rye Pond
EL. 355 LINE
KENSICO DAM
WASTE WEIR
Valhalla
WASTE CHANNEL BRIDGE
TAKING line
N.Y.C.&H.R.R.
CONDUIT
Bronx River
Hills
No. White Plains
Silver Lake
PLAINS
Purchase
WHITE PLAINS
MT. PLEASANT
NORTH CASTLE
HARRISON
GREENBURG
2000 0 2000 4000 Ft
1 0 1 Km

FIG. 1.

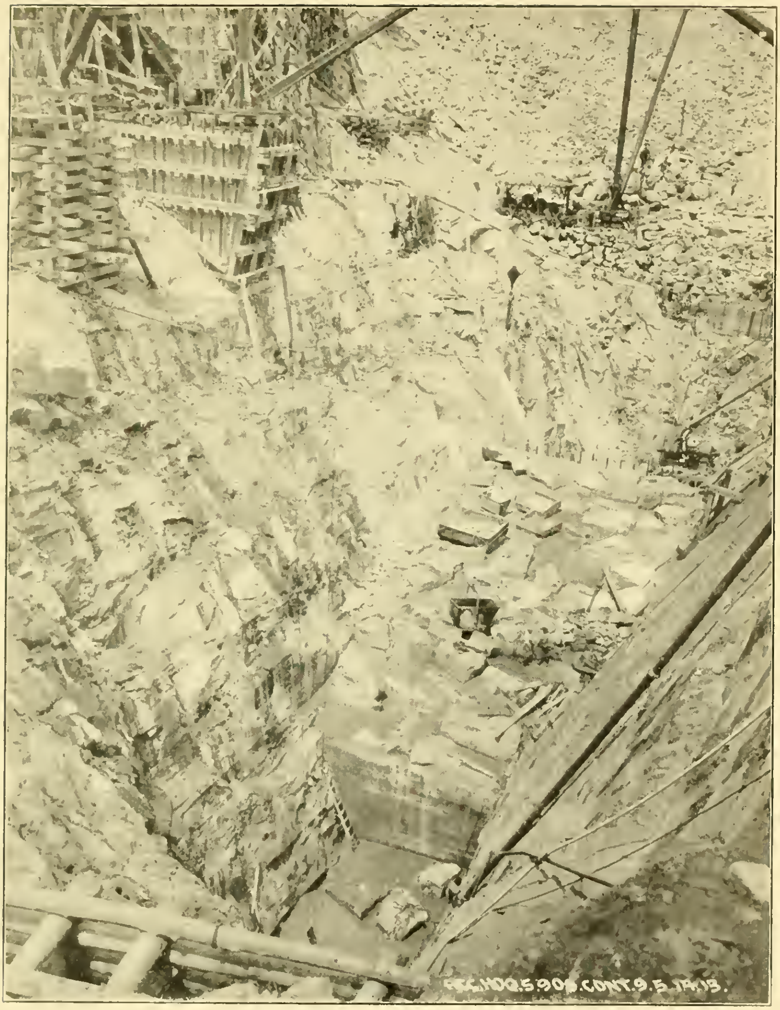
duct at this point is the same elevation as the normal surface of the full reservoir. The water after circulating through the reservoir will be drawn through a short tunnel on the west side of the reservoir about a mile north of Kensico Dam. Large gate chambers at both ends of this tunnel control the flow of water into the aqueduct. A reinforced concrete aqueduct connects the influent works with the upper effluent chamber, so that the reservoir may be by-passed and water sent directly to the city if desirable. It is expected to maintain Kensico Reservoir full, drawing upon it only in emergency.

The Kensico effluent works include an aëration basin, screen chamber, and reinforced concrete Venturi meter.

The by-pass aqueduct, connecting the influent and effluent chambers, is built along the west side of the reservoir and is a circular reinforced concrete structure 11 ft. in diameter. The reinforcing rods are $1\frac{1}{8}$ in. square twisted steel bars arranged in double rings, spaced 18 in. apart longitudinally. The construction of this reinforced aqueduct was required to be monolithic. It was built in sections about 45 ft. long, the forms for which were especially designed and furnished by the Ransome Concrete Machinery Company. The circular inside form was supported on short pier blocks located between the reinforcing rings. The entire mass of concrete forming a section was placed continuously, and special devices for compacting the concrete in the invert under the inside form and around the reinforcements were resorted to. Each section 45 ft. long was built in a day.

The upper effluent gate chamber, through which the water is drawn from Kensico Reservoir to the city, is 52 ft. square, with the gate sills at Elev. 291.3. The water is controlled by a double set of four 5 ft. by 8 ft. sluice-gates, and the by-pass aqueduct connects with this gate chamber. After leaving this chamber, the water passes through a tunnel 1 600 ft. long to the lower gate chamber. This is 82 ft. by 100 ft., with floor level at Elev. 295.32. This chamber controls the water, delivering it directly to the aqueduct or to the aëration basin, or to turbine wells, in which power may be developed by using the available head when the aërator is not in use.

The Kensico aërator is a large concrete basin 460 ft. long and



GENERAL VIEW OF GORGE.

240 ft. wide, with six lines of reinforced concrete supply pipes discharging through 1 750 nozzles arranged in rows and groups, which with different sizes and shapes of jets will make a wonderful fountain. The nozzles are designed with spiral veins, which cause the water to break into a fine spray, aiding in the oxidizing effect of the air by exposing the drops for several seconds, thus removing many of the causes of disagreeable tastes and odors. The aërator when operating will absorb about 25 ft. of available head. As the aërator will pass the entire flow of the aqueduct, it is believed to be the largest fountain in the world. The water, after falling on the floor, flows through a slot into a collecting conduit beneath the floor, which conducts it back to the aqueduct.

After leaving the Kensico Reservoir, the aqueduct is subject to a head of about 35 ft., and the cut-and-cover portion is built with heavy reinforcement. It is circular in section, similar to the by-pass, 17 ft. in diameter, and the reinforcements are $1\frac{3}{8}$ in. square twisted steel rods arranged in double rings $7\frac{1}{2}$ in. apart longitudinally.

After leaving the lower effluent chamber, the aqueduct passes through an air remover, a connecting chamber which received the water from the aërator, a screen chamber, and a Venturi meter. The latter is 216 ft. long, with a throat 8 ft. 9 in. in diameter.

The preliminary surveys for the reservoir were begun in 1906, and construction on the portion of the aqueduct adjacent to the reservoir and the effluent works was started in 1909.

By far the most important structure of the reservoir is the Kensico Dam, a straight masonry dam of gravity type, having a length on top of 1 843 ft. and a maximum height of 307 ft. from the lowest point in the foundation to the surface of the roadway on top. It is 28 ft. thick at the top, and its profile is the heaviest and most conservative of all of the recent modern dams. It is built of cyclopean masonry. The upstream side is faced with concrete blocks, and the exposed portion of the downstream side is faced with cut stone masonry. It contains about 900 000 cu. yd. of masonry, and takes rank among the notable dams of the world, not only on account of its size, but on account of the unusual

method of construction which enabled an extraordinarily rapid progress to be maintained throughout its construction. The contract for the dam and reservoir was awarded to Rodgers, Rodgers & Haggerty in December, 1909, and was assigned to H. S. Kerbaugh, Inc., in September, 1910. The amount of the contract, based on the bid prices and the preliminary estimate of quantities, is $7 953 050.

The first work to be performed under this contract was the construction of the substitute reservoir and the relocation of the highways affected thereby. The substitute reservoir was formed by two rolled embankment dikes, each about 45 ft. high, one across the outlet from the Rye Ponds and the other across the upper valley of the Bronx River. The crest of the spillways was Elev. 318. These two basins were connected by a small tunnel 600 ft. long. Together, they afforded an available storage of 5 064 000 000 gal., and lie wholly within the limits of the new reservoir. This substitute reservoir was connected with the Bronx conduit by a 36-in. riveted steel pipe two miles long. A matter of special interest in the dikes was the construction of the timber cut-off walls. These were specified to be tongue and groove sheet piling, 6 in. thick, extending from a concrete footing in the cut-off trench to a point above the flow line. The sheeting was to be placed vertically and supported by horizontal wales. The difficulty of supporting long lengths of sheeting in an upright position and placing a compacted fill close to it suggested the feasibility of placing the wales vertically and laying the sheeting horizontally as the embankment rose in height. The sheeting was composed of three thicknesses of 2-in. spruce, dressed on both sides, spiked together in such a manner that the middle piece formed the tongue. But instead of making up the sheeting beforehand, the separate boards were placed between the wales with the proper lap at joints and spiked in place.

The temporary reservoir covered 708 acres, 200 acres of which was swamp land at an average depth of about 28 ft. below the surface of the full reservoir. A large portion of these swamps were of considerable depth. Samples from a depth of 30 ft. showed more then 35 per cent. of organic matter, and they were covered by a rank growth of tussocks and other swamp vegetation.

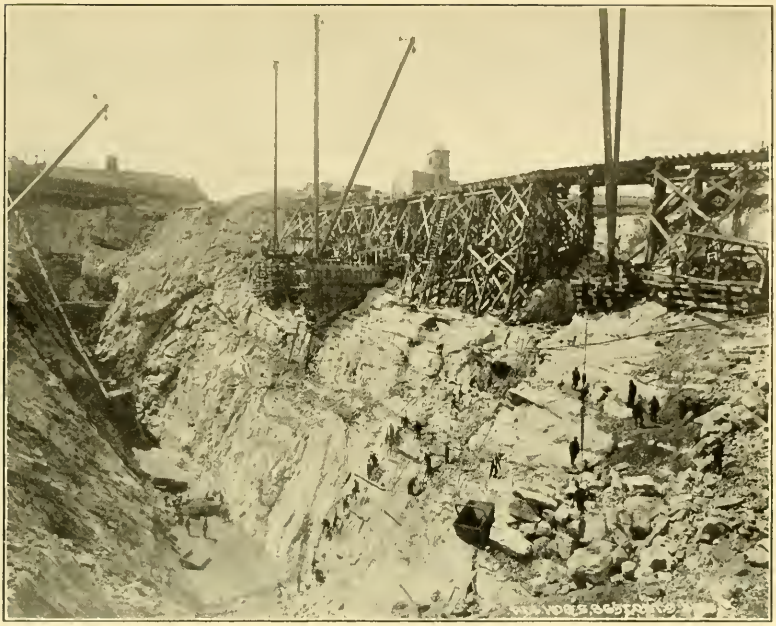


FIG. 1.
West face of gorge.

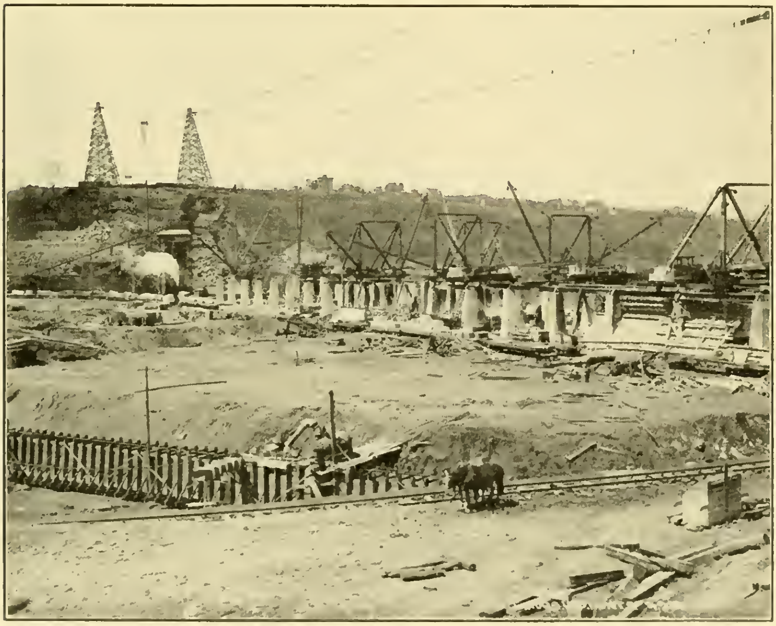


FIG. 2.
Fill on downstream face, showing method of supporting traveler tracks on concrete piers.

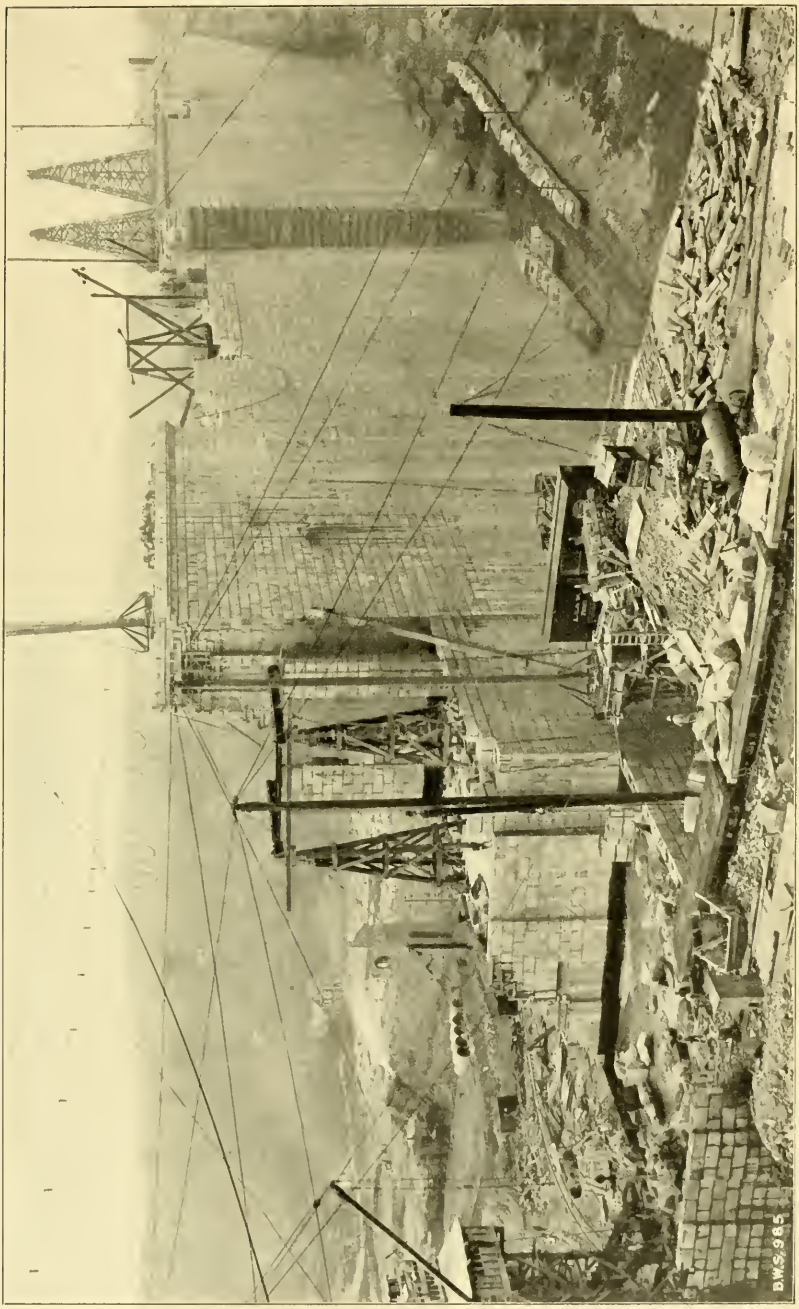
It was feared that these swamps would impart both tastes and odors to the water to an objectionable extent, and as it was essential to use the water as soon as it could be stored, they were cleared and covered with a layer of soil about one foot deep, which acts as a blanket to prevent the decomposed organic matter from mingling with the water. Favorable material was found in borrow pits on the sides of each swamp. Steam shovels and an equipment of narrow gage locomotives and four-cubic-yard side dumping cars were installed by the contractor. The swamps were first cleared by cutting off the surface growth, including tussocks, down to the general swamp level. After drying in piles for several months, the tussocks were easily disposed of by burning. The covering material was run out on to the swamp in ten-car trains over tracks of 60 lb. rails carried on 8-ft. ties laid on the cover. After dumping, it was spread to about 12 in. Over the shallow and dry swamps it was found that this depth of cover could easily support the tracks and train loads, but on the deep swamps, especially when they were saturated after heavy rains, the tracks would repeatedly break through the cover, and it was necessary to increase the depth to about 18 in. This would usually support the load, although it would deflect several inches as the trains passed over it, causing an alarming wave to those who were not used to it. At first the material was spread out by hand shoveling, but later the contractor provided car scrapers which were operated by locomotives.

The highway relocation involved the construction of about nine miles of new road and three reinforced concrete bridges, the largest about 900 ft. long, containing five segmental arches of 125 ft. clear span. Each arch is composed of two ribs of Melan construction, which carry spandrel arches supporting a reinforced floor. The central piers are more than 100 ft. high to the springing line. The exposed surfaces of the bridges are of granolithic finish, tool dressed.

Impounding of water in the temporary reservoir was begun August 17, 1911, and on September 8, 1911, when there was only 6 ft. of water covering the main swamps, the reservoir was put in service. A small aërator was built on the pipe line, and the quality of water from this temporary reservoir has been satis-

factory from the first, there being no objectionable tastes, color, or odor at any time.

After the substitute supply works had been completed, the old Kensico Reservoir was drawn off and the work of excavating the foundation for Kensico Dam was begun in the fall of 1911. The side hills of the Bronx Valley at the site of the dam rise about 180 ft. above the floor of the valley, the lowest point of which is at Elev. 200 above sea level. The east hill is of Fordham gneiss, and the west hill of Manhattan schist with very light cover of soil. Between these two formations is a stratum of Inwood limestone about 400 ft. thick. Geologically the valley is an eroded limb of a simple fold with a strike nearly north and south, or at right angles to the line of the dam, and an average dip to the west of 55 degrees. The floor of the valley at the dam site is about 900 ft. wide, with from 10 to 30 ft. of modified drift overlying the bedrock. Some of the material is very fine, analyses showing that 96 per cent. will pass a No. 50 sieve. The core borings of the preliminary surveys revealed a preglacial gorge in the vicinity of the contact between gneiss and the limestone about 50 ft. wide at the top and about 120 ft. deep below the floor of the valley. At the depth of 30 ft., and again near the surface of the disintegrated rock at the bottom of the gorge, layers of coarse sand and gravel were found. The bottom of the gorge still held about 40 ft. of disintegrated rock that had not been removed by the glacial scour. The excavation for the dam was started with three steam shovels, the material being removed in eight-yard car trains of standard gage, and was disposed of in the low ground below the dam. The grading for the plaza and approach took care of practically all of the excavation from the dam site, which amounted to 600 000 cu. yd. As the excavation reached the low level of the very fine material, some difficulty was experienced in supporting the shovels. The material was so fine that it held the water, and although it would stand in a vertical face 10 ft. high in front of the shovel, when it was subjected to vibration under the shovel it would soften up so that the shovels were continually settling in the soft material. Finally recourse was had to floating the shovels on rafts made in sections of three 14-in. by 14-in. timbers 24 ft. long bolted together. These sections of raft were taken up,



VIEW OF UPSTREAM FACE.

moved ahead, and placed by traveling cranes operating on the muck tracks. After the rock was uncovered, it was drilled and blasted to depths of 10 to 15 ft. and removed by the shovels.

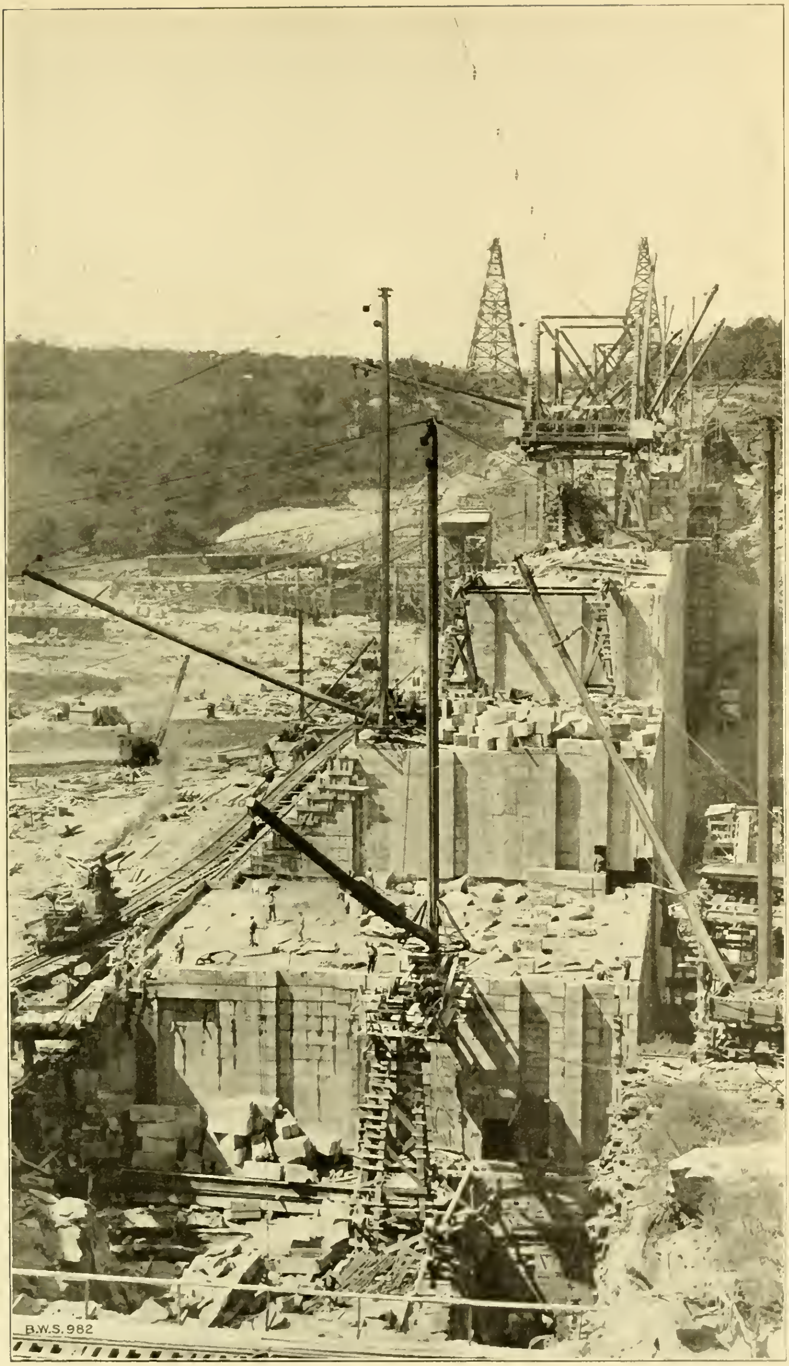
For the purpose of intercepting any possible seepage under the dam, a cut-off trench 20 ft. wide and from 20 ft. to 30 ft. deep was excavated in the solid rock foundation under the upstream face of the dam, extending the entire length, except at the ends above Elev. 300. This trench was excavated to such depths as to be below any open seams in the rock, and the sidewalls of this trench afforded an excellent opportunity for judging of the nature of the rock foundation.

The excavation in the gorge was carried along simultaneously with the rock excavation on the broad area and was prosecuted vigorously during the entire calendar year of 1912. At first the material was handled by two steam shovels into four-car trains which were hauled up an incline on the north slope of the gorge excavation. As soon as the depth was reached at which the two shovels could not work conveniently in the narrowing gorge, one was removed. The remaining shovel carried the excavation down to Elev. 80, the material being lifted in eight-yard skips by the cableways. The excavation was continued by hand until the solid contact between the gneiss and the limestone was reached. This was found at about 130 ft. below the surface of the valley.

The excavation revealed sound rock for the foundations everywhere very close to the elevations assumed from the core and diamond drill borings. These borings gave especially close results in delimiting the gorge, and demonstrated the wisdom of careful preliminary explorations. Satisfactory foundations were found at all points; even the limestone presented no unusual problems. Although similar to the formation under the new Croton Dam, it is of more sound character, and such erosions as were found were only of superficial nature. Bedding seams more or less open occurred in all three rock formations, but the cut-off trench was carried below the point where these could have any significance. Moreover, a number of drill holes crossing these seams at varying depths up to 25 ft. were made and grout pipes inserted. After a sufficient depth of masonry had been placed, careful tests with colored water under 100-lb. pressure failed to

reveal any unsatisfactory conditions. Subsequent grouting to refusal under pressures up to 100 lb. has produced a tight and satisfactory foundation. After a satisfactory rock had been reached by the ordinary methods of excavation, the foundation was prepared by removing all loose pieces by barring and wedging, and this painful operation was continued until the surface was sound and massive. The surfaces were then cleaned with jets of water and air and vigorous brooming. Just before the masonry was placed, a rich mortar was spread over the rock surface and broomed into all the seams and irregularities.

One of the fundamental features in the design of Kensico Dam is its division into sections longitudinally by transverse contraction joints. These are located about 80 ft. apart throughout the length of the dam, and greatly facilitated the construction, in that any section could be built up to any desired height irrespective of the adjoining section. The faces of the contraction joints are formed of concrete blocks laid up in such fashion as to form tongues and grooves running vertically, each 10 ft. wide. Taking advantage of this feature, the contractor conceived the plan of placing the masonry on the broad area west of the gorge by a number of stiff-leg derricks mounted in pairs on travelers, which could be moved on elevated tracks supported on concrete piers erected on the foundation for the dam. (Plate XXIX, Fig. 2.) Two lines of traveler tracks running longitudinally with the dam permitted four travelers to be placed in pairs facing each other over each section of the dam between contraction joints, thus making eight derricks available for each section. The piers supporting the traveler tracks were 6 ft. square at the base and 4 ft. at the top and 25 ft. high, and were built in place of mass concrete by the cableways. They were spaced longitudinally about 40 ft. apart, or one half the length of a section. The girders were 28-in., 80-lb. Bethlehem H-beams. The travelers were 30 ft. wide and 39 ft. long. The derrick booms were 57 ft., each operated by a double-speed 75 h.p. electric hoist. Between and on the outside of the traveler tracks were service tracks carried on piers, upon which shuttle cars operated, which brought the concrete in bottom-dumping buckets of two-yard capacity from the mixers located at the ends of the dam. The large cyclopean stone was delivered



CROSS SECTION OF DAM.

to the outside derricks over tracks laid on the refill on both the up- and down-stream sides of the dam. The advantages of this plant arrangement over those recently employed in the construction of large masonry dams are the readiness with which the derricks can be moved from section to section and the direct delivery by rail to the derricks of the materials.

The concrete blocks forming the upstream face of the dam are 2.5 ft. high and from 5 to 6.5 ft. long. They are arranged in alternate header and stretcher courses. The arrises are finished with a radius of 1 in. The blocks for the contraction joint facing are 2.5 ft. high and 5 ft. long. These blocks were all made in the special yard south of the dam, and were set in the same manner as ashlar masonry with 1 in. mortar joints.

The masonry in the cut-off trench was usually placed first, and was of a richer concrete than that in the main body of the dam, being in the proportions of one part of cement to six parts of aggregate, and no cyclopean stone was placed in the north half of the trench. The concrete in the body of the dam was in the proportion of one to nine. The blocks forming the upstream face and the faces of the contraction joints were laid a course at a time, and these served as forms to hold the cyclopean masonry, the downstream face of the dam being built against timber forms. During the busy part of the season, the concrete blocks were laid at night. The concrete piers supporting the traveler tracks were built in and became a part of the masonry. As soon as a section was completed to the level of the tracks, the travelers were moved to an adjoining section. When a considerable portion of the dam was finished to the elevation of the tracks, the piers for the next lift were built by the cableways and the tracks re-erected. Eight travelers made it possible to work on two sections at once in this portion of the dam.

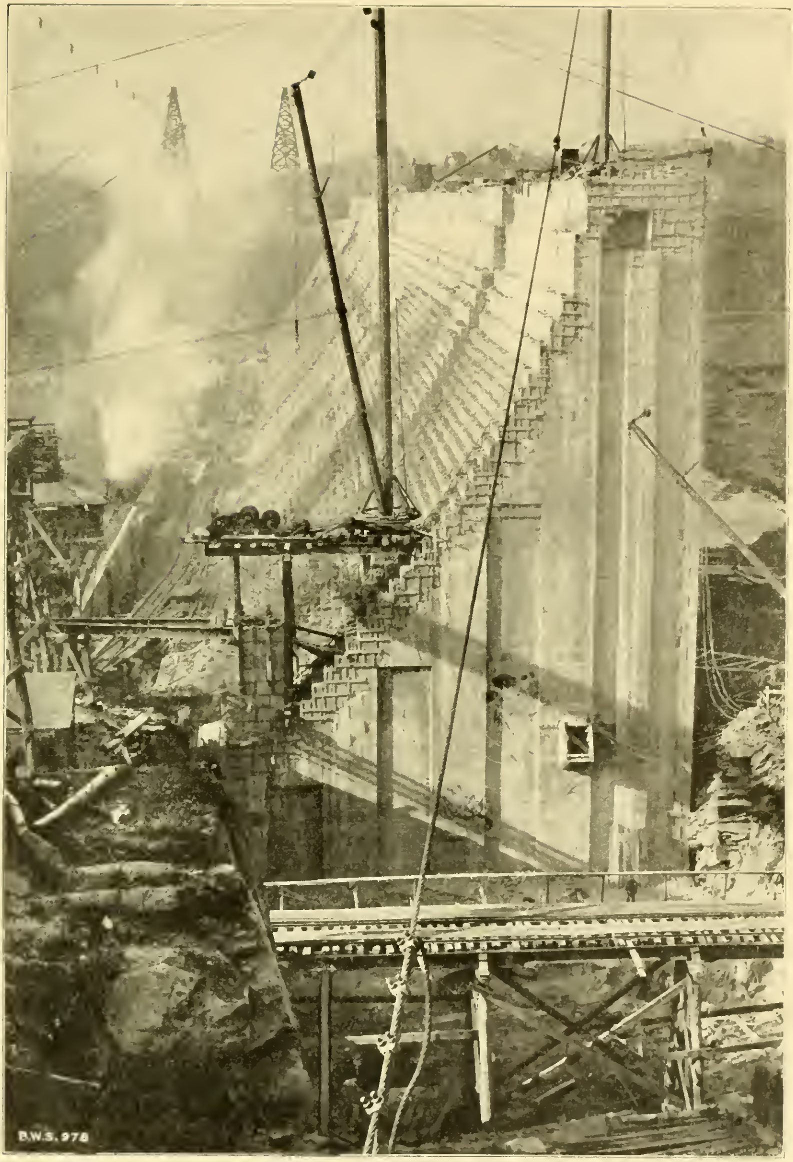
The depth of the gorge made the placing of masonry in it a separate problem. A row of 90-ft. guy derricks on both sides of the gorge covered the whole area, and these were served by two concrete mixing plants located one on each side of the gorge, so that the derricks could reach the hoppers from the mixing units directly.

The placing of masonry in the gorge was begun early in March,

1913, and after the bottom was placed, it progressed rapidly throughout the season. After it reached the elevation of the derrick bases they were raised and placed on top of mass concrete piers which were included in the masonry. Early in October, construction on the second traveler lift was begun. The progress on this lift was more rapid than on the first because of the narrower section and the more uniform depth. By the end of the season, the masonry in the gorge had been completed to the same elevation as the rest of the dam, so that during the following season the traveler method was extended over the whole length between the hillsides. At the close of the season the dam was completed to Elev. 214 for a length of 869 ft. A total of 316 000 cu. yd. of masonry was placed during the season of two hundred working days of eight hours each. The best day's record was 2 250 cu. yd. of masonry placed. The cyclopean stones were all large derrick stones, many of them running as large as 8 cu. yd. During the winter of 1913–14, refill on both sides of the dam was placed to the elevation of the completed masonry, so that the entire volume of masonry placed during the year was buried.

During the early spring of 1914, the traveler tracks for the third lift were erected, the three concrete plants were relocated so as to meet the needs of the coming season, one at the base of each hill on the downstream side and the third on the upstream face at the east end. The service tracks were arranged on the refill on both sides of the dam, and the general plant tuned up for the effort of the coming season. The laying of masonry was resumed early in March. While the travelers were building section after section of the main portion of the dam, guy derricks were building the hillside sections at the east and west ends, and as these were completed up to the level of the central portion, the traveler method was extended. By the end of May, the third lift was completed and work on the fourth lift commenced. The top of the third lift, Elev. 239.5, coincided with the elevation of the terrace on the downstream face of the dam, which is the beginning of the face masonry. Above this elevation, the downstream face of the dam was formed in steps to receive the stone masonry facing to be placed later.

On the fourth lift several radical changes were made in the



Cross Section of Dam.

arrangement of the travelers. At this elevation, the width of the dam was so reduced that the whole width could be covered by a single traveler, necessitating but one traveler track. The eight travelers were now arranged in pairs, permitting the construction of four sections at a time. Instead of building mass concrete piers, sections of the contraction-joint block facing were built up and used for supporting the traveler track girders. The projecting ends of the header blocks were supported by concrete slabs or filler blocks laid with mortar joints. The ends of the girders between the joints were supported on movable timber towers. This change proved very favorable, as the timber tower and tracks could be entirely removed from the section under construction, and the block piers were more easily erected than concrete piers. The downstream service tracks for the fourth and subsequent lifts were relocated at the elevation of the terrace wall, the inner track being carried on the bench for supporting the base of the face masonry, the outer track on the piers which supported the outer girder for the third lift traveler track.

The construction of the fifth lift was similar to that of the fourth. The booms of the downstream derricks were lengthened to 67 ft. to enable them to reach the concrete tracks on the terrace. The sixth and seventh lifts were built in a similar manner. The reduced width of the dam enabled a greater depth of masonry to be laid in a day, and two courses of facing blocks were laid at a time. At the seventh lift, the piers carrying the downstream traveler rail projected above the face of the dam. The eighth and top lift, completing the dam to Elev. 370, was built with the travelers on the seventh lift track. The traveler derricks, working above themselves to the extent possible, were assisted by guy derricks placed on top of the dam. After the travelers had built all but the sections of the top lift they were occupying, they were removed and the closures made by guy derricks.

At the close of the season of 1914, the dam had been completed to the top for a length of 1 400 ft., the east end, which terminated abruptly part way up the east hill, leaving a contraction joint face 140 ft. in clear height. 489 750 cu. yd. of masonry had been placed in 221.5 working days of eight hours each, or an average of 2 211 cu. yd. a day for the entire season, nearly equaling the

best single day's work of the previous year. The largest day's work for 1914 was 3 572 cu. yd. This achievement is a record in dam construction, and is believed to be the greatest mass of masonry ever placed in a single structure in the same length of time. The accomplishment of this feat was due not only to the very liberal construction plant, but depended upon a careful arrangement of all the details and a very efficient organization. When it is considered that this work required an average delivery to the derricks of 4 000 tons of material a day, which at a maximum amounted to 7 000 tons in a day, the magnitude of the transportation problem will be better appreciated. That this supply was never seriously interrupted is the best evidence of the contractor's organization. The crushed stone for the concrete, the large fragments of cyclopean stone, and the dimension stone were all obtained from a quarry specially opened about a mile east of the dam. The cyclopean stone averaged 27 per cent. of the mass, and the cement factor for the two years was 0.84 barrels of cement per cubic yard of masonry.

The most interesting features in the plant arrangement were the use of the traveling derricks, the mixing of the concrete at conveniently located points instead of a central plant, so that the time of delivery to the derricks was reduced to a minimum, and the advantage taken of the facility afforded by the contraction joints for building up independent sections. The most interesting plant not already described was the two cableways which covered the entire length of the dam, having a span of 1 860 ft. They were carried on movable timber towers 125 ft. high. The main cable of each span was $2\frac{1}{2}$ in. in diameter. Their capacity was about twelve tons, with a running speed of about 800 ft. per minute. These cableways were used primarily for handling and arranging the plant. They were used to some extent for removing excavated material, principally from the gorge. They were not used for placing masonry except the concrete in the track piers. Two one-yard Ransome rotary mixers and three two-yard gravity mixers of the Haines-Weaver type made all the concrete used in the dam. During the second season, a large output was obtained from the latter mixers, the largest day's work for any one mixer being 653 batches in eight hours. The

mixers were located at convenient points in timbered towers of such height that the bottom hopper discharged directly into the buckets carried on the shuttle cars. Above the mixing floors were bins to which the aggregates were delivered by belt conveyors which drew the materials from storage bins. The materials were brought to the storage bins by standard railroad equipment running on overhead tracks. The freight cars which brought the cement in sacks from the mills were run directly alongside of each mixer. The sacks were unloaded by hand and placed upon belt conveyors which delivered them to the mixing floor. All of the plant at the dam, excepting the locomotives, was electrically operated by alternating current furnished by the New York Edison Company over a specially constructed high-tension power line located along the aqueduct right-of-way from Yonkers to Valhalla. Electricity is also used for operating the crushing plant at the quarries and the air compressors which furnish power for the quarry drills and the stone-dressing machines.

The concrete block plant consisted of a traveling platform spanning three rows of steel block-forms. On the platform were three one-yard rotary mixers, one over each line of forms, into which they discharged directly. The mixers were supplied by materials from overhead bins, which were in turn supplied by a telfer operating on a cantilever beam which was served by trains of flat cars carrying bottom-dumping buckets containing the aggregates. The hoist which operated the telfer supplied the motive power for moving the traveler. The blocks are all cast with the exposed face downward, which produces a very smooth, dense face. After the blocks were hard enough to move, they were piled by traveling cranes and left for thirty days to strengthen.

For the supply of all the stone required for the dam, the contractor purchased a favorable quarry site about a mile east of the dam, and built a double-track stone-ballasted standard-gage railway connecting it with the east end of the dam, his plant yards above and below the dam, and the Harlem Division of the New York Central Railroad. The production of crushed stone and cyclopean stone involved quarrying on a large scale, including blasts of 100 000 cu. yd. The material for the crushers was handled by steam shovels, and the crushing plant contained some

of the largest units ever built. The architectural plans required many large dimension stones, and an excellent stock was obtained for this purpose. The stone is a gneissoid granite, having an interesting grain and diversity of color due to the including minerals.

The work of dressing the 22 000 cu. yd. of dimension stone has progressed continuously for two years, and still involves the employment of nearly one hundred stonecutters. Much of the work is done by machinery, pneumatic surfacing tools and pneumatic plug drills being used wherever possible.

The work of the present season includes the completion of the east end of the dam and the placing of the dimension stone facing, the grading of grounds and driveways below the dam, and the final clearing of the reservoir. This work is so far advanced that it is expected to begin filling the reservoir in November, 1915.

Because of the magnitude of Kensico Dam and its conspicuous location, being at the northern terminus of the Bronx River Parkway, and the fact that it is the most imposing visible structure of the Catskill Aqueduct, it was thought proper to give it suitable architectural treatment. The design contemplates emphasizing the size and proportions of the dam. The most important feature is the cornice or finial line of the top of the dam, extending for 1 800 ft. in a strong horizontal line, including a frieze roughly carved to suggest the classic design of shield and wreath. This is flanked at the ends by semicircular cut stone pavilions of classic design. The horizontal base of the dam across the valley is marked by a broad terrace rising 10 ft. above the general level of the approach. This terrace is 1 000 ft. long and its ends are marked by twin pavilions and broad flights of steps leading down to pools and fountains. The motif of the design for the face of the dam was suggested by the structural feature of the contraction joints, and the face of each section is treated as a panel separated by heavily rusticated bands, which rise from the terrace to the coping. Within a border of smooth cut stone, the field of each panel is composed of roughly squared masonry in which appear projecting headers arranged in diaper pattern. The central portion of the face is flanked by pylons which rise from the ends of the terrace. Beyond these the panels are con-

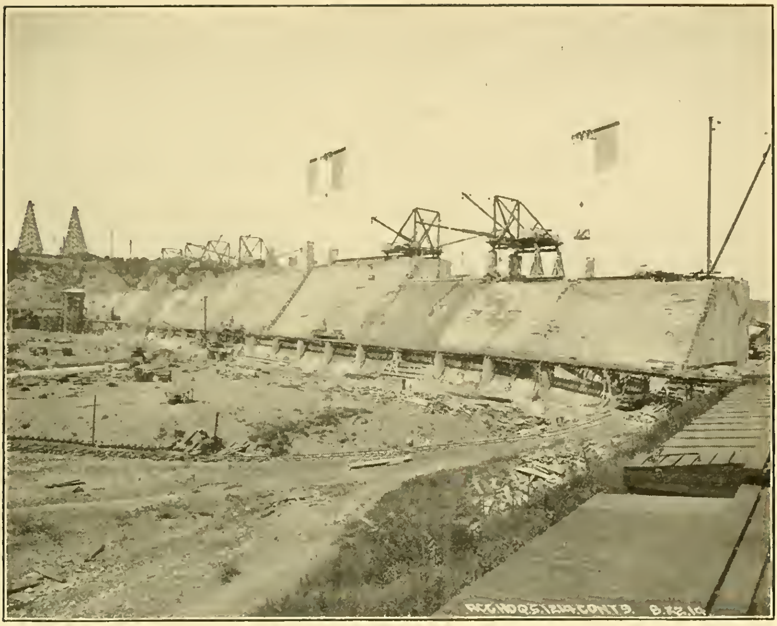


FIG. 1.
General view of dam.

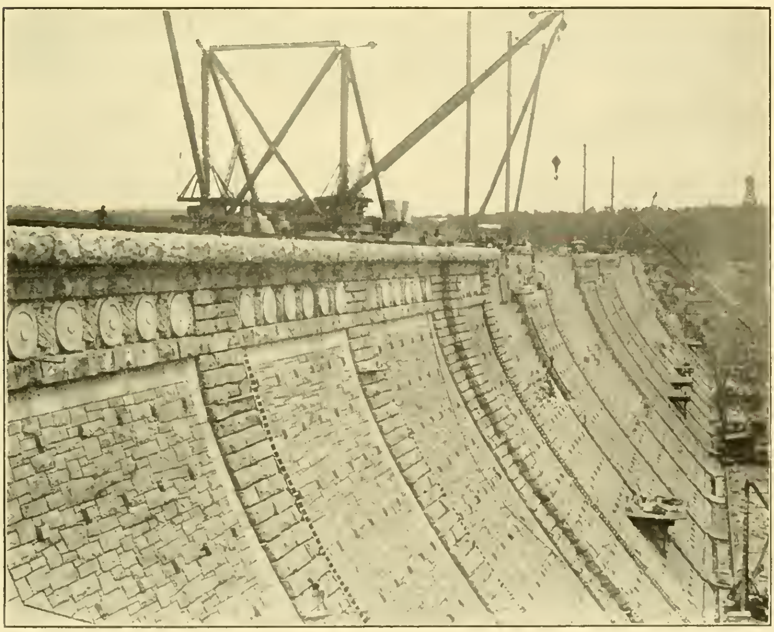


FIG. 2.
Dimension stone on face.

tinued up each hillside, making an harmonious treatment of the whole face. The torus is 4 ft. high and the frieze course $6\frac{1}{2}$ ft. high. These involve very large stones weighing up to 14 tons. The rough dressing of the surfaces and the wide jointing express the magnitude of the structure, which in itself is its chief element of beauty. In front of the terrace below the dam will be a large pool with fountains, paths, and driveways. This more formal area is approached by broad avenues traversing a gradually descending plane nearly 2 000 ft. long. The whole area will receive adequate landscape treatment, and will form a suitable setting for so notable a structure.

SANITARY IMPROVEMENT OF A LARGE WATERSHED.

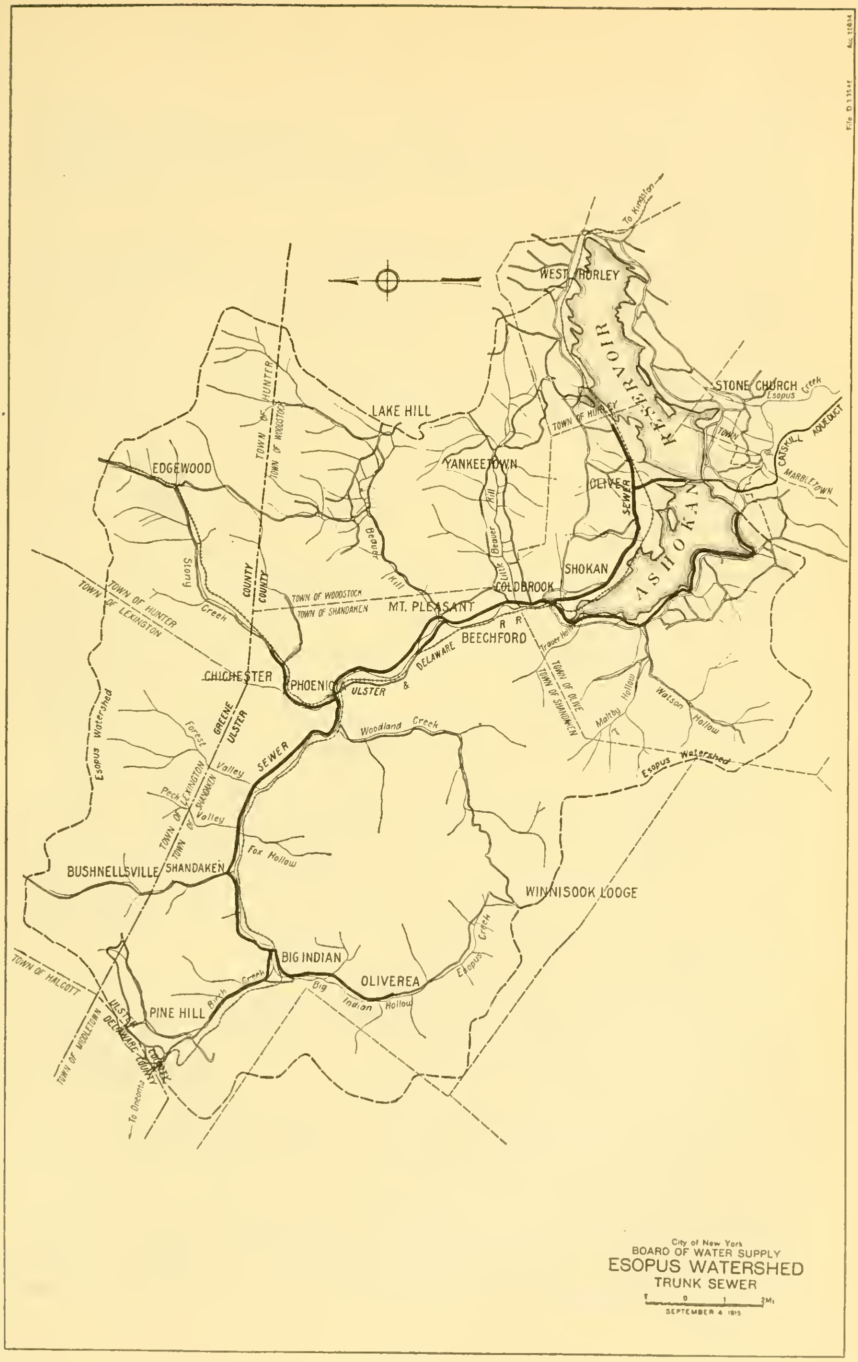
BY GEORGE G. HONNESS, DEPARTMENT ENGINEER OF THE BOARD OF WATER SUPPLY, NEW YORK.

[*Read September 7, 1915.*]

Tributary to the Ashokan Reservoir, now being constructed by the Board of Water Supply of the City of New York as the principal storage reservoir for Catskill Mountain water, there are 257 square miles of drainage area. A considerable portion of this is uninhabitated, being wild forest land. The population is concentrated along the valleys and consequently adjacent to the streams feeding the reservoir. This mountain region is a favorite summer resort for city people, and this fact leads to a wide variation between the summer and winter population. It has been estimated that the summer population is 10 000 and the winter population 3 000, being 39 per capita per square mile and 12 per capita per square mile, respectively. Two of the principal centers of population have public water supplies but no sewerage system; there are also many large hotels without adequate methods of sewage disposal; and the tendency of the entire region is to be exceedingly lax in the disposition of all wastes.

Fig. 1 shows the reservoir and the drainage area and the relation of one to the other, and the relative areas which are to be cared for by a trunk sewer and by individual sanitary treatment.

It has been appreciated by the Board of Water Supply that the sanitary conditions of the watershed needed improvement, and consideration of a sanitary survey made it evident that two separate methods for sanitary improvement should be considered, — one for the important centers of population and one for the outlying districts. For the former it was suggested that a sewer be built in the main valley, with branches in the side valleys to the important centers of population, the sewage to be treated at a



City of New York
BOARD OF WATER SUPPLY
ESOPUS WATERSHED
TRUNK SEWER
SEPTEMBER 4 1915
ASHOKAN RESERVOIR
WEST HURLEY
STONE CHURCH
LAKE HILL
YANKEETOWN
EDGEWOOD
OLIVE
SHOKAN
COLDBROOK
MT. PLEASANT
BEECHFORD
CHICHESTER
PHOENICIA
SEWER
BUSHNELLSVILLE
SHANDAKEN
WINNISOOK LODGE
BIG INDIAN
OLIVEREA
PINE HILL
Esopus Watershed
CATSKILL AQUEDUCT
ULSTER & DELAWARE R R
To Kingston
To Oneonta

Fig. 1.

disposal plant downstream from the reservoir. For the latter it was concluded that resort should be had to individual sanitary treatment. This was to include improvement of privies, cesspools, barnyards, etc.

A survey for the sewer was made, and this showed that the sewage could be conducted to a disposal plant by gravity, although a short length of pressure pipe would be required. It was necessary to go to the legislature to gain permission to construct this sewer in the public highways, ample authority having been granted in the statute creating the Board of Water Supply for all other features. A bill was presented to the legislature of 1914, but failed to pass because the people of this region hoped that if a sewer was not built the city of New York would ultimately be compelled to purchase the entire territory as a protection to the purity of the water. The bill was not clearly drawn, and this helped to make the success of its opponents easy.

The sanitary survey above referred to divulged the fact that some few places had no provision in the way of privies, and that in a large majority of cases no pits were provided, fecal matter falling into a dry run or a small drainage course. The privies themselves were in many cases dilapidated buildings, with no protection against flies and no provision for proper ventilation. It was decided to furnish privies where none were in use, replace disreputable ones by new ones, repair and provide ventilation and screens for all privies that were in reasonably good condition, and in all cases place the buildings over pits about six feet deep with sides walled up with dry stone and located as far as possible from a watercourse.

A sanitary privy was designed as a portable building, so that it could be built at a shop and delivered in sections at the place of erection. The privies were 4 ft by 4 ft. 3 in., provided with ample ventilation from beneath and behind the seat up through a small box chimney to the height of the roof, a good-sized window which was screened with copper screening, and a door with a latch and spiral spring which insured it being kept closed. Additional ventilation is secured by holes bored in the peak covered by screening on the inside. The construction of these buildings cost the city about seventeen dollars each for labor and materials. This

does not include the cost of erection, which is small when the cost of hauling is excluded.

The statute creating the Board of Water Supply gave it authority to enter upon private property to improve sanitary conditions, the entire expense to be borne by the city of New York. With this authority, a start was made in improving the outlying districts. This work was at first viewed with distrust by the natives, and much objection and many prejudices had to be overcome before the work went smoothly forward; but under the skillful handling of Mr. Sidney K. Clapp, a member of this society, all these difficulties were gradually overcome. At places where our efforts were met by strong objections on the part of the property owners, the work was temporarily deferred and adjacent places improved, but ultimately the owner who had first objected asked that improvements be made on his property. By this procedure, we did not force our rights under the law, but by tact and diplomacy accomplished the same object without friction, retaining the goodwill of the people among whom we were working. It is only fair to say in passing that the bulk of the derelictions from good sanitary conditions were due to thoughtlessness and not to a wilful desire to injure their neighbors.

The work of improving the outlying districts was nearing completion when the 1914 legislature refused to pass the Esopus Valley Sewer Bill, so that it was decided to follow the above-outlined policy of individual treatment throughout the entire watershed.

Incidental to this work, an inspection has been made of all premises supplied with running water, and the means of disposal of sewage investigated. The results of this inspection are recorded in sketch form, with sufficient notes to record the actual conditions at the time of inspection. Where conditions need remedying, work is being undertaken to build or replace cesspools or install adequate methods of treatment.

For the work a gang of from ten to twelve men has been employed during the entire year, although little can be accomplished on outside construction in the winter season. Since the work started, a total of about 600 premises have been improved, 112 of this number having been provided with new privies, 7 with new

cesspools, and about 20 with cesspools improved and made more efficient. An incinerator has been built to dispose of the garbage of one community, with the understanding that it will be operated by the village authorities.

These efforts have brought about a noticeable improvement in conditions, and have awakened the people of the region to an appreciation of the necessity for better sanitary conditions.

In all this work we have profited by the assistance of the local health officers of the towns, who have shown their willingness to coöperate in bettering the health conditions. We have also been aided by the State Health Department, which has shown a marked appreciation of the necessity of guarding the public health through its potable water supplies.

ELECTRICALLY OPERATED VALVE INSTALLATIONS AND THEIR CONTROL FROM A DISTANCE.

BY ALFRED WILLIAMSON, MECHANICAL ENGINEER, DEPARTMENT OF WATER SUPPLY, GAS, AND ELECTRICITY, NEW YORK.

[*Read September 8, 1915.*]

In the event of a break in any part of the high-pressure system in Manhattan, it is possible to immediately divide the network of mains into three districts from one of the pumping stations by means of electrically operated gate valves in the streets.

Two of these districts are separated by a line which extends across the city about midway between the two stations, and the third is wholly included within the limits of one of these larger districts and constitutes what is known as the duplex system. This protects an area on the southeasterly side of the city, the mains in that section being so connected that in the alternate streets they receive pressure from one feeder and in the other streets from another feeder, both of which are separable at the pumping station, the only physical connection between the two sets of mains in the streets being through the motor-operated valves controlled at the stations. The various hand-operated valves on the boundary lines of the districts are always closed. In order to maintain good distribution, the motor-operated valves are ordinarily kept open.

Two of these valves were installed in 1911, one at New Chambers Street near Pearl about one-half mile from the Oliver Street Station, and one on Houston Street near the Bowery, about one and seven-eighths miles from the Oliver Street Station. These are 16-in. Chapman valves operated with 2.5 h.p. 230-volt motors. The power is taken from the nearest service box in the street, and the operating or control cables are carried to Oliver Street Pumping Station in ducts. The operating or auxiliary current is 115 volts.

In 1913 three more valves were installed, one in connection

with the duplex system described above and two for the purpose of separating the stations. It was decided at the time to keep the stations regularly separated, and for that reason, on the theory that the valves would be opened with full pressure on one side, 5 h.p. motors were used in these two instances. It has proven impractical, however, to keep the stations always separated, principally because of the difficulty of giving reliable service on the border line, as alarms are frequently sent from boxes some distance from a fire, and the pressure might be applied to the wrong side of the system.

The distances from the point of control for these recent installations are as follows: The valve located on the Bowery south of Houston Street is one and one-half miles from the Oliver Street Station, the one located at Stone Street near Whitehall Street is one mile from the Oliver Street Station, and the one located at North Moore and Hudson streets is one and three-quarters miles from the Gansevoort Street Station.

In each station there is a panel board with labeled operating switches for each valve and index lamps showing red when the valve is open and green when the valve is closed. When the switch is thrown the motor in the vault is started by means of an automatic starter operated by a auxiliary circuit. The motor is geared directly to the operating nut on the valve stem. Attached to and revolving with the operating nut is an extension sleeve provided on the outside with a fine thread on which the reversing switch collar travels as the sleeve revolves. The position of this collar is adjustable so that the limits of its travel may be accurately set. The operation of the reversing switch results in shutting off the motor and reversing the field connections for the next start. The signal lamps at the station and in the valve vault are also changed in this operation.

The only mechanical difficulty encountered so far has been the separation of the extension sleeve from the operating nut on one valve. This permitted the motor to drive the wedge down on the seats rather hard before the overload relay broke the circuit. The operating nut and sleeves are now made in one piece, and no more difficulty is anticipated from this cause. The electrical repairs in the past two years to the five valves have cost $120,

which was expended principally in replacing solenoids and coils in the panel boards in the vaults, which while sealed with gaskets and heated by a 16 c.p. carbon lamp are still to some degree affected by dampness. A repair charge averaging one dollar per month per valve, however, is not alarming.

The valves are operated every day from the station, and are inspected, cleaned, and lubricated every month. The cable insulation is tested every month. It may be interesting to note that the February test on one cable indicated an insulation resistance of 1 655 megohms per mile, while the same cable in July possessed an insulation resistance of only 365 megohms per mile. It is expected that next February the resistance will be back to 1 655.

The two valves originally installed cost $9 895, including vaults, panel boards, and control apparatus. The cables cost $3 200. The three later valves were installed with the rest of the distribution system and their cost is not definitely known. The cables, panel boards, and all control apparatus for these three valves cost $10 397. In order to determine upon proper charges to be paid for power for operating these valves, tests were made in opening and closing with 200 lb. pressure on one side. The maximum power at the moment of starting to close was 5 h.p. The maximum time for closing was 25 seconds; the maximum power at the moment of opening was 4.3 h.p., the maximum time of opening being $28\frac{1}{2}$ seconds.

It was expected that some difficulty would be encountered in keeping these vaults dry, and where permissible drains have been installed through traps to the sewer. Several of the vaults, however, are too low to be so drained, and the installation of siphons was considered, but they have not been found to be necessary. Leakages from valve stuffing boxes are almost wholly avoided by the monthly inspection. The operators at the pumping stations are instructed to close all motor-operated valves when a sudden or unusual discharge occurs while the station is operating at a fire or while the system is not under pressure. When pumps are in operation, the station operator is at the switchboard and will detect a sudden discharge immediately on the Venturi meters directly in front of him. When the station is not pumping, however, the operators are not attentive to the meters and, therefore,

signal bells and automatic cut-outs have been installed on the low-pressure by-pass meters connecting the supply to the high- pressure system. The ringing of the bell will, of course, call the operator's attention to the unusual flow through the meter, and the automatic cut-out will prevent the loss of mercury which would otherwise result from such flow.

DISCUSSION.

Mr. William F. Sullivan. I would like to ask how long after starting pumps the pressure is up on the whole system.

Mr. Williamson. The pressure is up within half a minute after the pumps are started; within a minute, usually, after the alarm is received.

PUMP SLIP TESTS AS AN AID TO EFFICIENCY IN THE OPERATION OF PUMPING ENGINES.

BY H. T. HAVILL, ASSISTANT ENGINEER, DEPARTMENT OF WATER SUPPLY, GAS, AND ELECTRICITY, NEW YORK.

[*Read September 8, 1915.*]

There is an abundance of data on the method of obtaining efficiencies in the steam end of pumps, and much time and labor is spent in accomplishing that end, while in most cases very little concern is given to determine the condition of the water end, where in many cases the greatest economy can be secured, unless there are definite outward indications of something wrong.

The water end of a large pumping unit is the vital end, from the water-works engineering viewpoint, for while the steam end may be working with the highest degree of fuel economy, slippage in the water end would entirely nullify the efficiency of the unit. Pumps in our stations contain as high as 480 small valves in the water end, any one of which is liable to accidental damage or wear resulting in sudden and unobserved development of slippage.

It is necessary to know frequently the quantity of water the pump will displace per revolution, to make up an honest daily log sheet from which the efficiency of the unit and the actual amount of water delivered for consumption may be calculated.

In the New York City water works, regular quarterly pump slip tests are made with a pitometer to accomplish two very important ends, the first being to determine the condition of the water end of the pump and the second to determine for record the amount the actual discharge differs from the theoretical so as to know the net gallons per revolution delivered.

It is seldom when these slip tests are made that we do not find a number of the pumps slipping from 10 to 15 per cent., and very observing operating engineers when told the amount can hardly believe it, due to the absence of any blowing, pounding, or other outward indications of inward disturbances. However, when he

opens up the water end of the pump he invariably locates the trouble and the slip is cut down often as low as 2 to 4 per cent.

To illustrate by an actual instance the value of the determination by slip test of the condition of the water end, I give below the results obtained in a recent case before and after the slip determinations and repairs.

Cost of pumping	5c. per million gallon feet.
Theoretical displacement	10 mil. gal. per day.
Discharge pressure	50 lb. or 115 ft.
Total daily work performed	1 150 m. g. f.
Slip of pump first test	13 per cent.
Loss per day of energy due to slippage	$1\ 150 \times .13 = 149.50$ m. g. f.
Loss per day in fuel consumption and other operating expenses,	$149.50 \times .05 = \$7.47$
Slip of pump after repairs	3 per cent.
Net saving in slippage due to repairs	10 per cent.
Saving per day in energy	$1\ 150 \times .10 = 115$ m. g. f.
Saving per day in fuel consumption and other operating expense,	$115 \times .05 = \$5.75$

In the above case, after the slip test revealed a faulty condition, the water end of the pump was opened up and examined. It was found that there were six springs broken, and a piece was out of one valve, which had been renewed only a few days previous. This condition was not apparent from the working of the pump and, had it not been for the slip test, would not have been known.

To obtain the most value from the slip test when trouble in the water end is indicated, the pump should be tested again as soon as repairs are made, to determine the amount of saving and to know that the trouble has actually been corrected. It often happens that the engineer when overhauling the pump will locate some small trouble with the valves or springs and repair them and, believing that that was the whole difficulty, close the pump up again and not search further, when the greatest trouble may have been overlooked.

The necessity of the determination by the slip test of the actual gallons displaced per revolution is of decided importance as affecting the accuracy of the records of output, and needs no discussion.

LAYING WATER PIPES IN CONGESTED STREETS, NEW YORK CITY.

BY M. BLATT, C.E., ASSISTANT ENGINEER, DEPARTMENT OF WATER SUPPLY, GAS, AND ELECTRICITY, NEW YORK CITY.

[*Read September 7, 1915.*]

New York City, in consequence of its character as a still growing metropolis, has in almost every field a range of conditions from the simplest to the most complex. Thus there are many sections of the city in which pipe laying is no more difficult than in any small town or village, but in lower Manhattan any operation which involves the disturbing of the street surface and calls for underground construction brings with it, in addition to the usual engineering problems, a multitude of incidental ones, which must also be handled and solved by the engineer as a part of the whole engineering work under his charge.

In the narrow, curving streets of lower Manhattan, crowded normally to the limit with pedestrian and vehicular traffic, any constriction of the roadway by excavations in the street creates a traffic problem of first-rate importance. Allied therewith is the problem of arranging and carrying on the work so as to reduce to a minimum interference with normal business along the street. No less important is the safeguarding of the public against accident. Even minor accidents in an area of large crowds and high values have potentialities for heavy damage suits against both the contractor and the city. However, all of these matters are but incidental to the work. The principal problem lies not above but below the street surface. Crowded as the roadway may seem, the space below it, in lower Manhattan, is still more congested.

Many of the roadways downtown are less than twenty-five feet in width, some being as narrow as ten feet. In the space on each side of the sewer, which often occupies the major portion of the street, there are crowded, in irregular alignment, water mains, a multiplicity of gas mains, duct-banks and distributor conduits

for telephone, telegraph, and electric power service, pneumatic tubes of the mail service and of the various telegraph companies, steam pipes encased in jackets increasing their diameter more than double, and a number of other minor pipes and conduits. To these there must be added, in some important cases, the substructure and power conduits of the underground electric trolley, the Rapid Transit Subway, with its shallow covering, the column bases of the elevated railroad, and the tracks of the steam railroads and of the storage battery and horse-drawn street cars. The roadways, narrow as they are, are often further encroached upon by sidewalk vaults extending well beyond the curb line, and in some isolated cases beyond the middle of the street.

In the broader avenues, also, the available space is occupied by trunk mains and heavy lines of conduits. Fifth Avenue, with a forty-foot roadway between sidewalk vaults, contains two 48-in., two 36-in., a 20-in., and a 12-in. water pipe, seven gas mains, and four heavy banks of ducts. Broadway, near Twenty-fifth Street, with a 45-ft. roadway, has in addition to the trolley tracks and conduits, ten gas mains, a 12-in. water pipe, and five banks of ducts, the largest of which is 4 ft. wide and 2 ft. deep. In Tenth Avenue, the roadway of which is 60 ft. wide, there are two tracks of the New York Central Railroad, a street-car track, a 30-in., 20-in., 16-in., 12-in., and 8-in. gas main, two small and one large bank of ducts, and a 36-in., 12-in., and 6-in. water main. Similar conditions obtain in others of the wider streets.

The subsurface structures usually found in the street occupy the space between planes two feet and seven feet below the street surface, forming a network which often makes it impossible to excavate below a depth of two feet, without removing one of them. At street intersections, which in this section are closely spaced and often irregular, this network becomes a complete tangle. A large portion of lower Manhattan is low-lying, and the sewers are old and at shallow depth. Tidewater and sewers themselves add to the difficulty of finding room for an additional pipe.

In this crowded section of lower Mahnattan, considered by many the most congested with subsurface structures in the world, there were laid within the last nine years one hundred and twenty-eight miles of new mains comprising the Manhattan high-pressure

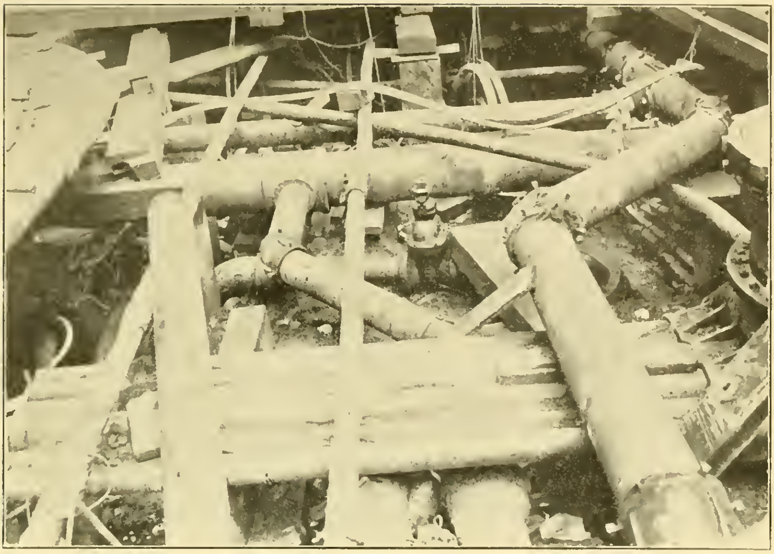


Fig. 1.

Southwest, Broadway and Spring Street, looking north. May 5, 1911.

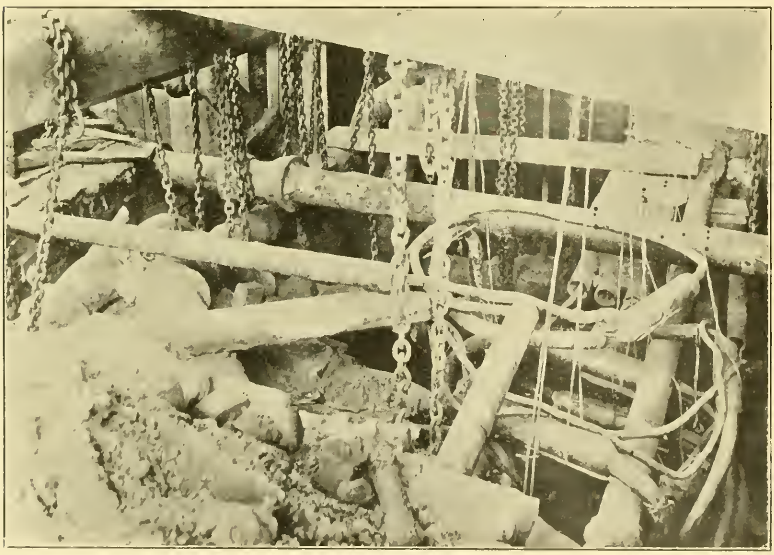


Fig. 2.

Northwest, 9th Avenue and 23d Street. Showing obstructions to be moved to permit the enlargement of the Electric Company manhole. Looking east in excavation, showing Electric Company subway running east and west on north side of 23d Street to the right. April 8, 1910.

fire system; a complete new network of water pipes, the laying of which involved the tearing up of almost every street within the entire district south of Thirty-fourth Street on the west side, and south of Houston Street on the east side of Manhattan Island.

Investigations of subsurface conditions in advance of construction work were at no time complete enough to determine even a general alignment for the new pipe in the street. When the first section of the Manhattan high-pressure system was planned the Bureau of Subsurface Structures, a recording bureau, had not been established in Manhattan. The attempt was made to determine in advance the location for the proposed mains by extensive test pit digging and plotting of the structures found therein. This attempt was abandoned as too costly, and the information obtained was found to be of little value. The alignment of the new mains was almost uniformly determined from an examination of test pits dug as the work progressed, together with such information as could be obtained from the incomplete records of the various departments and public service corporations, and from surface indications of existing subsurface structures. Some special investigations were, however, made in advance of the work, covering points known to be exceptionally difficult and complicated, such as street intersections along the route of the Rapid Transit Subway. The selection of locations for hydrants required a complete investigation and plotting of sidewalk vaults, which in the business section of Manhattan exist in front of almost every building. Detailed surveys of many of these vaults were required for the purpose of planning the construction of recesses to be built therein for the setting of hydrants.

A most important item of the work was thus the alteration and reconstruction of existing structures, which was necessary to make room for the new mains. These alterations were both extensive and costly. In connection with a contract for 14 miles of mains out of the total of 128 miles mentioned, existing water mains were rearranged at 234 locations, sewers and sewer structures were altered or reconstructed at 104 points, 55 waterproof recesses were built in existing sidewalk vaults to provide room for hydrants, and there were issued to public service corporations 649 orders for alteration, removal, or reconstruction of pipes, con-

duits, or other structures owned by them. The cost of the last-named item to the companies was a considerable one. In William Street, south of Maiden Lane, the reconstruction of a heavy bank of ducts for telephone cables cost the company owning it $5 000. Alterations to gas mains ordered during the year of 1914 in connection with the laying of these new water mains amounted to approximately $20 000.

The service of the public service corporations in many sections would not bear lengthy interruption without great inconvenience and often monetary loss to their consumers. Compelling quick action by the companies and assuring coöperation with the city and its contractors was often difficult. Yet there were many instances, such as the intersection of Frankfort and William streets, where, in accordance with special arrangements, five public service corporations removed their structures, which were badly intertwined, and replaced them again on the same day, a holiday, after the city's contractor laid the new water mains across the intersection. Many delays were, however, unavoidable, and in these cases the complaining citizen with letter-writing tendencies was in evidence.

At many points unusual construction had to be resorted to, or special provisions made to carry on the work. At Fourth Street and Broadway, after a number of unsuccessful attempts to lay a 20-in. main at normal depth, a small timbered tunnel was driven under Broadway at a depth of seventeen feet, and the main laid therein. In West Broadway, the trunk sewer is so close to the surface of the street that practically at all of the street intersections the mains had to be laid below tidewater, crossing the street underneath the sewer, which itself is built on treacherous ground. Similar conditions existed along Sixth Avenue and along the streets near the river front. The mains in Broadway and Sixth Avenue, and along a portion of West Broadway, have been, or are now being, rearranged in connection with subway construction. The old Rapid Transit Subway is at many points so close to the street surface that it was necessary to reconstruct sections of the subway roof to provide room for laying a main across it. Along Seventh Avenue the shallow depth of the subway north of Twenty-third Street made it necessary to lay the new

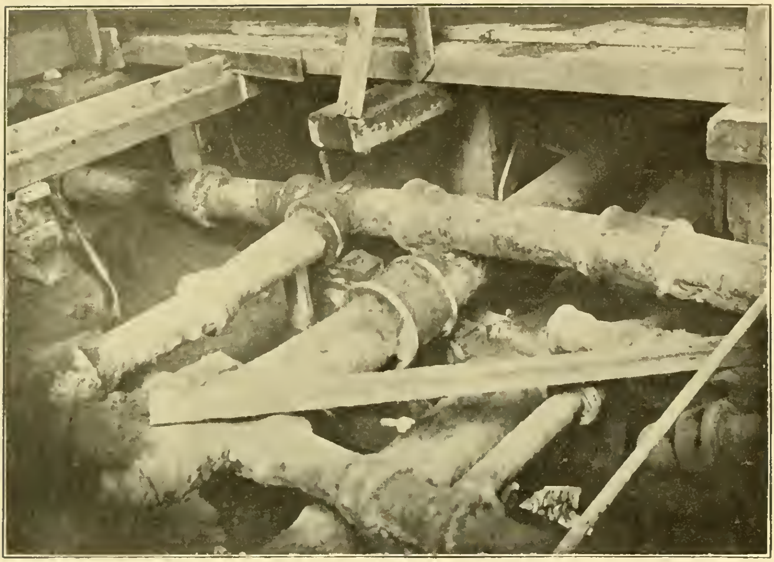


FIG. 1.

6th Avenue and 23d Street. Showing pipes during trolley construction, 1897.

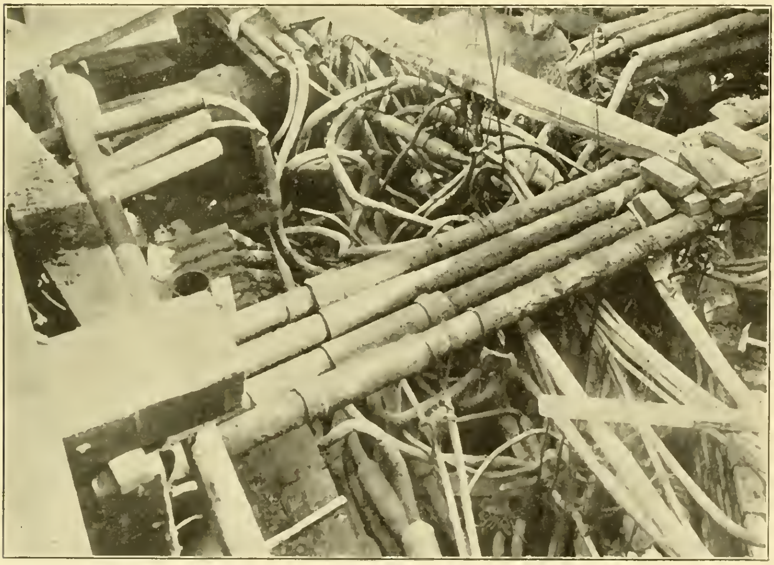


FIG. 2.

Southwest, Broadway and Houston Street. Looking southeast, showing cables in Electric Company manhole and pipes surrounding same, during Rapid Transit Subway construction. Manhole in course of reconstruction. March 20, 1914.

FIG. 1.

22d Street, east side of 4th Avenue, looking west.

FIG. 2.

Northeast, 6th Avenue and 12th Street. Rearrangement of pipes made necessary by construction of McAdoo Tunnel. Consolidated Telephone and Edison Service Company's service box spanning two 20-in. water mains with four 4-in. I-beams. Clear span, 5 ft.

main under the sidewalk, destroying thereby a number of sidewalk vaults along the street. In lower Fifth Avenue and lower Broadway, and at many other points, traffic conditions made it impossible to do work in normal working hours, and practically all of the work in these streets had to be done between Saturday noon and Monday morning. At many street intersections existing pipes formed such a complicated network that the entire intersection had to be tunneled, in some cases for a distance of one hundred feet, and pipe dragged in. Where this occurred, the network of piping formed an excellent roof for the tunnel. On Center Street, south of Canal Street, a 20-in. high-pressure main was laid in a gallery constructed in connection with the Center Street subway. This gallery runs underneath the buildings on the west side of the street. Further south, the pipe is laid under the stairway and portals of the Tombs prison.

In digging the trenches, many interesting objects were uncovered. Old wooden water pipe of the early part of last century was very common. Much of it was in a good state of preservation. The wrought-iron bands at the bell ends were of especial interest. Wrought-iron wedge gates in these pipes were more rare. A bronze driven tap with a piece of lead pipe attached was found in one of these wooden pipes. Cannon balls and coins of the Revolutionary and Colonial periods were excavated in the streets near the south end of the island. At a number of points skulls and other human bones were plentiful. A broken coffin in Washington Square contained, among other things, a fine, red wig, and close thereto a pair of old brass knuckles were found. On Elizabeth Street, under the sidewalk, at a point where hundreds of people pass each day, there existed an empty brick well 28 ft. deep, covered over only by a badly broken piece of bluestone flagging. In Beekman Street, a five-way casting with four 6-in. and one 10-in. branches formed a part of the old water main in the street. A number of structures, privately owned, occupying the street without franchise, were uncovered. Among them was a small tunnel across the entire width of the street, built to transmit power from one building to another opposite. In a number of downtown streets abandoned wrought-iron mains of an old steam distribution system were removed to make room for the new mains.

These steam mains were, for insulation purposes, enclosed in a box filled with lampblack which attached itself to all of the workmen and to many of the passersby. On Front Street, for a distance of about two blocks, the trench pictured the history of the water main system for the last century. In this trench there were exposed the old wooden water pipe, an abandoned 6-in. water pipe laid early in the century, a 6-in. water pipe laid in 1888, and a 12-in. water pipe laid in 1904. The removal of the first three made room for the new high-pressure main.

That adverse conditions and the many difficulties encountered had little effect upon the quality of the resulting work, which was safeguarded by exacting specification provisions, is best shown by the results of the hydrostatic tests to which these one hundred and twenty-eight miles of mains were subjected after installation. The maximum rate of leakage allowed was four gallons per linear foot of pipe joint per twenty-four hours under a pressure of four hundred and fifty pounds maintained for twenty minutes. In the most difficult district covered, the average recorded leakage on fourteen miles of mains was only 1.7 gal. per foot of pipe joint per twenty-four hours. It is well, therefore, in even the most difficult situations, to remember the motto of one of the contractors' superintendents, — that nothing is difficult or impossible if you have the men and the money.

DISCUSSION.

Mr. J. M. Diven. Mr. Blatt's paper is going to be a great comfort to the speaker in years to come; when he thinks he is having trouble with a complication of pipes, electric ducts, etc., he will reach for the volume in which this paper is printed, and be convinced that he has very little trouble.

President Metcalf. It reminds me, Mr. Diven, of the comments of a witness on the witness stand in the Denver case, who under cross-examination on the possibility of using a trenching machine in the heart of the city replied that he saw no difficulty in doing it. I could not help wondering, when I saw these views, whether the gentleman would have said that a trenching machine could have been used here.

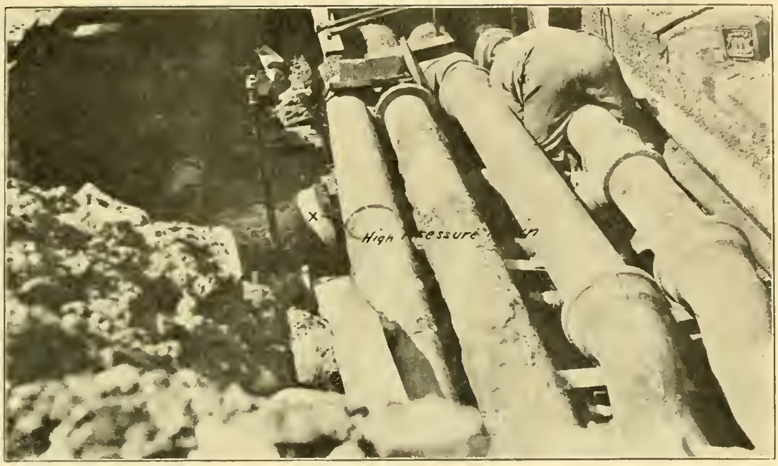


FIG. 1.

19th Street, west side of 4th Avenue, looking south.

FIG. 2.

Southeast, Broadway and Pearl Street, during Rapid Transit Subway construction. Looking southwest showing three banks of Electric Company subway ducts entering manhole, and also general conditions. December 14, 1914.

Mr. Diven. The speaker tried a trenching machine in a city street not quite as thickly populated with water pipes and underground structures as the streets shown by Mr. Blatt, and half a block brought trouble enough to stop the work. The gas company, sewer department, and all of the householders were up in arms, and with good cause, for the machine left wrecked gas services, sewer laterals, etc., in its wake.

Mr. Blatt. Specifications drawn in 1904 for some of these new mains contained a provision permitting the use of trenching machines. Their use was, of course, out of the question. On the contrary, short-handled picks and shovels were needed and used constantly, and one or two under-sized workmen were required in each gang. It was not unusual for a man to work for days in a cramped place shoveling earth into a pail with a little coal shovel, the pail being hoisted to the surface when filled.

CONTROL OF PUBLIC WATER SUPPLIES BY THE CONSERVATION COMMISSION OF THE STATE OF NEW YORK.

BY RUSSELL SUTER, ASSISTANT CIVIL ENGINEER, CONSERVATION COMMISSION, ALBANY, N. Y.

[*Read September 9, 1915.*]

In thinly settled parts of this country, especially where rainfall is abundant and streams numerous, there is little pressing need of state control of water-supply matters, and it has been the custom to allow each community to take possession of and use such water supplies as it saw fit. This has not always worked out well in practice, particularly in regard to the quality of the water supplied. As the density of population has increased and as cities have become large and their needs for water great, it has been found that the interests of the whole population require that the state shall intervene both to protect the public health and to act as umpire in apportioning among the various communities the water-supply resources needed by each. Practice in this regard has differed markedly among the various states which have taken up this work. This paper attempts to give a general outline of the work already done along these lines in the state of New York, together with some discussion of future possibilities in such matters.

Prior to the year 1905, the state of New York exercised control and supervision over public water-supply systems only through the legislature and the State Department of Health. The health authorities have only advisory powers. The commissioner of health has power to investigate any public water-supply system, to determine by inspection and analysis the quality of the water supplied by it, and to report his findings with recommendations. He has, however, no authority to compel compliance with his recommendations, and a municipality can continue to supply to its inhabitants water which he has condemned on sanitary grounds.

Legislative authority has been exercised to authorize certain cities to take water from stated sources, but more often in the direction of restraint than otherwise. Thus numerous special acts have been passed to prevent cities from entering neighboring counties in order to obtain a supply of water and other similar restrictions, most of which were directly aimed at the city of New York. This special legislation at times recoiled upon those it was intended to protect, as, for instance, in Dutchess County, where the restrictions are so drastic that villages in that county have difficulty in obtaining water supplies for themselves.

In 1905 New York City made application to the legislature for the powers necessary to enable it to obtain an additional supply of water elsewhere than from Croton watershed. In considering the needs of the city, the legislature seems to have decided that it was advisable to establish a state body which should have control of the distribution of the water-supply resources of the state among the inhabitants thereof, and in the session of 1905 not only passed an act creating the Board of Water Supply of the city of New York and authorizing that city to go beyond Croton River for its water, but it also created the State Water Supply Commission with broad powers over all municipal water-supply systems.

By this act of 1905, the State Water Supply Commission, composed of five members appointed by the governor, was created, and it was specified that thereafter any municipality or civil division of the state which proposed to acquire lands for a new or additional source of water supply must first submit the project to that commission and obtain its approval thereof. This act applied only to municipally owned water-supply systems, and only to projects which involved the acquisition or taking of land. Subsequently this law was amended. In 1906 it was made to apply to privately owned water-supply systems. Other amendments of minor importance followed. Finally, in 1911, the State Water Supply Commission was merged with the Forest, Fish and Game Commission to form the Conservation Commission, and the powers and duties of that commission in regard to water supplies were somewhat extended.

As the law now stands, no municipality, person, or water supply

company, proposing to install a new water-supply system or to obtain a new or additional source of water supply for an existing system, can carry out such a project until it has been submitted to and approved by the Conservation Commission. Formal petition in writing must be made to the commission, accompanied by plans, specifications, analyses, and reports bearing upon the matter. Upon receipt of such application, the commission causes notice to be given that on a day named it will hold a public hearing upon this application. At this hearing the applicants are required to give oral testimony with regard to the project, and any person who has previously filed objections to the granting of the application may be heard in opposition thereto.

After closing the hearing, the commission must within ninety days make a decision on the application. Originally, before approving such a project, the commission had to make in the affirmative the following determinations:

That the plans proposed are justified by public necessity.

That such plans are just and equitable to the other municipalities and civil divisions of the state affected thereby, and to the inhabitants thereof, particular consideration being given to their present and future necessities for sources of water supply.

That said plans make fair and equitable provisions for the determination and payment of any and all damages to persons or property, both direct and indirect, which will result from the execution of said plans.

The Conservation Law modified this last determination by inserting the word *legal* before the word *damages,* and this law also required two additional determinations:

That the plans provide for proper and safe construction of all work connected therewith.

That the plans provide for the proper sanitary control of the watershed and the proper protection of the supply, or provide for proper filtration of the supply.

In deciding an application, the commission must make its determinations and decision in writing. It can either approve the application as submitted, or with such modifications as it may determine to be necessary in order that it may make the above determinations, or it may reject the application entirely. The

commission may allow an application to be withdrawn, amended and re-submitted.

Prior to the enactment of this law, any community or any water company which had a contract for the supply of water for public purposes to any community could exercise the right of eminent domain to take any source of water supply not already appropriated for a public use. Since 1905 this right has been restricted by the requirement that a state commission must first approve of such taking. Undoubtedly the chief purpose of this was to prevent the appropriation of water rights by a powerful community to an extent such as to hurt the water-supply interests, present or future, of smaller communities — especially of such as had not yet established a water-supply system. It was also intended to prevent the speculative taking up of water rights for possible use in the remote future. It was clearly intended that no sources of water supply should thereafter be acquired except after careful consideration of the needs for water of all communities that might be supplied from each source. That such was the case is more clearly shown by certain further provisions of the law which will be mentioned later.

This matter of the apportionment of the water-supply resources of the state among the inhabitants thereof was undoubtedly the first consideration leading to the enactment of this legislation. As a matter of fact, it does not enter to any great extent into the considerations given to the majority of applications. It will, however, be of increasing importance in the future, as the number of systems and the demands for water must continue to increase.

In granting authority to the city of New York to go beyond Croton River for water, the legislature provided that, after an additional supply of water was obtained by that city, it should be lawful for any municipality in Westchester County to purchase a certain limited amount of water from any portion of the water-supply system of the city, and also that, if water from Esopus Creek should be taken by the city, the city of Kingston should have similar privileges. Thereafter the city of New York made application to the State Water Supply Commission for permission to take water from the Catskill Mountain sources. The commission withheld its approval of this project until additional legislation

was enacted, which provided that any municipality in the watersheds of Esopus, Rondout, or Catskill creeks, in the counties of Ulster and Greene, might take water from any of the new reservoirs to be built in those counties. Again, in approving the application of the city of New York for additional supplies in Nassau County, the Water Supply Commission required that municipalities in that county be permitted to take water from the New York City system under certain restrictions as to quantity taken and rate of payment therefor. In later applications the Conservation Commission has granted applications to municipalities to take water from sources already used by other municipalities, but in order to safeguard the rights of the prior user of these sources it has limited the amount of water which may be taken by the applicant. In other cases, permission has been granted to take water from some source, but the right has been reserved to allow other municipalities to take water from the same source.

The third of the original determinations has caused more discussion than any of the others. At the time of the enactment of this law, it was evident that New York City was about to take extensive tracts of land and build large storage reservoirs. It was felt that provision should be made for the payment of damages to persons and property upon a scale hitherto unknown in this state. The original Board of Water Supply act provided in detail for the procedure in the case of condemnation of property and also provided that the owners of property which was not taken by the city, but which was damaged by the city's operations, should be compensated. Before approving the city's application for the Catskill Mountain sources, the State Water Supply Commission required a still more liberal measure of damage and would not grant the application until legislation was enacted which provided that the city: Construct and forever maintain the necessary highways and bridges about the reservoirs; provide police protection along the line of the work; build certain necessary new sewers in the city of Kingston; and pay indirect and business damages, including salaries and wages to the employees in manufacturing establishments who might be thrown out of work by the carrying out of the project. This legislation was modeled in large measure

upon the statutes of the Commonwealth of Massachusetts, which authorized the work of the Metropolitan Water Board.

The State Water Supply Commission always held that the legislature intended, by the passage of this act, to provide for the general payment of indirect damages in the case of taking of lands for the construction of reservoirs and other structures, and that commission frequently required that the petitioner in any proceeding stipulate that it would pay indirect damages. In the case of municipalities, such a stipulation would be of doubtful force unless the legislature had previously given such municipality authority to pay indirect damages. It does, however, appear that the commission could refuse to grant an application on the grounds that indirect damages should be paid and therefore that the project should not be approved until the legislature had given authority to pay such damages.

Public necessity is a term so broad that many considerations other than those above mentioned could be included under it. The Water Supply Commission held that questions of quality of water could be considered under this head, and in one case rejected an application on the grounds that public necessity for the supplying of water not fit for drinking could not be shown to exist. That consideration was to be given to the quality of the water was indicated by the fact that an eminent authority on sanitation and water analysis was appointed a member of the first commission. Under this head also the question of the safety of the proposed works was considered. At a later date the legislature specifically required determination to be made as to quality of water and safety of works.

A study of the various decisions made by the commission indicates that the availability of a proposed source and the cost of water therefrom were considered proper subjects for study under the head of public necessity. Objections have been made under this head to projects for taking water in order to supply manufacturing industries, and above all to the establishment of competing systems, of which more below.

Since the formation of the State Water Supply Commission, one hundred and ninety-five applications have been filed. Of this number by far the greater part have been approved, and in

most cases of rejection a subsequent modified petition has been made and approved, and the works finally constructed. At times the commission has been criticised because it has rejected so few applications. The number of such rejections cannot be taken as a measure of the value of the work done by the commission. A large percentage of the applications submitted to it are granted only in a modified form, and not infrequently these modifications are so drastic as to constitute a rejection of the original project and the substitution of another in lieu thereof. Such modifications are usually intended to improve the quality of the water proposed to be supplied, as by the installation of filters or other means of purification. Frequently the applicant is required to procure the enactment by the State Department of Health of rules and regulations for the sanitary control of the watershed which it is proposed to use. Modifications are frequently required in the plans to make the proposed works safe and also to make them adequate to perform the service evidently expected of them.

This again brings up the question of provision for payment of damages. It has been held that the commission cannot find that due provision for such payment has been made where it is clear that sufficient funds are not available for the completion of a project. Applications have been denied on these grounds, or have been granted only on condition that sufficient additional appropriations be procured. No projects are considered by the commission unless the construction of the system has been duly authorized by vote or otherwise. Such authorization usually includes the appropriation of the necessary funds. If, thereafter, the commission requires extensive changes and additions, additional funds are usually needed also. It is under such circumstances that the above questions are apt to arise.

To make effective the requirements of the commission, it is necessary to obtain its approval of the completed system before such system may be operated.

Most of the contested cases which have come before the commissions have been applications by a municipality for approval of the installation of a publicly owned water-supply system when the field was already occupied by a private company. In such cases the company usually has argued that public necessity did

not exist for the installation of a competing plant, and that, if such a plant were installed, provision should be made for the payment of damage to the existing company for loss of business. In several cases applications for the installation of such competing systems have been granted, resulting generally in the purchase of the existing system by the municipality. Some duplicate systems have, however, been installed. In these cases the commission seems to have found that the system operated by the company was not giving service or supplying water of quality such that it would be justified in finding that public necessity for a better system did not exist. It has required drastic revision of the plans for the new system in order that it may be certain that an adequate supply of water of suitable quality shall be obtained and that the new system shall be in all respects better than that already installed. This sometimes requires a materially larger expenditure for the new plant than was originally contemplated. The question of the payment of damages to the existing company has never actually been determined.

In all these matters the commission is particularly guided by that section of the statute which requires it in all cases to make a reasonable effort to meet the needs of the applicant.

Curiously enough, although the decisions of the commission are reviewable by the courts and this statute has been in force for ten years, only one decision has ever been argued on appeal and in that case the appeal was dismissed with rather brief consideration.

In forming the Water Supply Commission, the legislature seems to have had in mind that the time had come to initiate steps towards coöperation in the water supply matters, a form of cooperation which is still unknown in this state, although now familiar to everybody in Massachusetts. It was required that the State Water Supply Commission in its first annual report should make a statement concerning the available sources of water supply in the state, the respective purity and quantity of each source of supply, and the availability of each to be used for localities other than those immediately adjacent thereto. The commission was also to report where each municipality at that time got its water, and where and how it disposed of its sewage.

It was also to report the advisability of, the time required for, and the expense incident to, the construction of a state system of water supply, and for a state system for the disposal of sewage. It was manifestly impossible for the State Water Supply Commission in less than a year to make a comprehensive report upon these matters.

In the first and second annual reports issued by that body, the results of a so-called census of water-supply and sewerage systems were published. The commission also reported that it failed to find that necessity existed for a state system of water supply or sewerage at the present time, although it pointed out that there were three areas in the state in which the density of population was such that coöperation in water-supply matters might become advisable. These are: Greater New York and Westchester; the district including Albany, Troy, and Schenectady; the district including and extending north and east of Buffalo. No recommendations were made at that time as to the methods of supplying water to these districts, the commission finding that the matter was unimportant. Events proved that this opinion was not in all respects correct, and the report might well have been different if made at a later date.

During the summer of 1910 a severe drought was experienced in the eastern part of the state of New York, which particularly affected Westchester County. The State Water Supply Commission made a special investigation of this county and its needs for a water supply, and thereafter published an outline of a comprehensive scheme for supplying the entire county by a coöperative system which could obtain water from Peekskill and Popolopen creeks. From these studies it appears that, by coöperation on the lines familiar to the people of Massachusetts, all of Westchester County could be supplied with water of good quality, by gravity, and at a cost probably less than that at which water can be purchased from the city of New York under the provisions of the Board of Water Supply act. More or less interest was shown in this report, but no definite steps have ever been taken to carry out the recommendations of the commission. No settlement has yet been reached in this problem of supplying Westchester County, and it will certainly come up again. The situation there is com-

plicated by the large number of private systems and agitation for municipal ownership.

Some years later it became evident that the municipalities in the district lying between Rochester and Buffalo were insufficiently supplied with water. In this thickly populated district nearly all the systems were taking water from wells and springs. This is a limestone country and the water obtained is all hard and limited in quantity. It is frequently stated that the only running stream in this section is the Erie Canal, the waters of which are not potable. The Conservation Commission discovered that this entire district, including the cities of Tonawanda, North Tonawanda, and Lockport, could be supplied with water by gravity from a single large impounding reservoir on Little Tonawanda Creek south of the city of Batavia. Surveys and estimates on this project were made by the commission in sufficient detail to determine that the scheme was feasible and that the cost of water would be reasonable.

Unfortunately, the coöperative idea was not favored by the numerous municipalities in this district, and no steps were taken to carry the project through. Since that time several of these communities have installed new systems, usually at materially greater expense than would have been required to meet their share of the coöperative scheme.

Studies were later made for a gravity supply for Cohoes, Watervliet, Waterford, and Green Island, communities on the Hudson River just above Albany. It was found that this district readily and cheaply could be supplied with good water and by gravity. Some steps were taken to carry out this project, but nothing has come of it.

Coöperation has not yet succeeded in this state, but it must come. Aside from local jealousy and politics, the chief difficulty has been the method by which funds can be raised for the purpose. If the state could have gone ahead and built the works with state funds, as in Massachusetts, something might have been accomplished. Unfortunately this state cannot by act of legislature appropriate more than one million dollars for any project unless such appropriation has been approved by referendum vote of the whole state. It would be difficult in the extreme to get the people

of the whole state to vote money for the installation of a water-supply system in a small section, even with the provision that the district benefited extinguish the debt thus created.

Provision has been made for the establishment of union water districts, including a certain number of municipalities having more than a certain population. The Conservation Commission may, on application from the municipalities composing such a district, make surveys, plans, and estimates for a water-supply system to supply such district. Estimates of the cost of installing such system may be prepared, and this cost apportioned among the constitutent municipalities. If thereafter each such municipality shall issue bonds in the amount of its share, the system may be constructed and operated by the Conservation Commission. That commission will act only as wholesaler of the water, as the Massachusetts Metropolitan Commission acts. Each constituent municipality will construct its own distribution system and take its water supply off the district mains through a meter.

Activity along these lines may be expected, but not in the immediate future. It is the opinion of the writer of this paper that even now most of the smaller communities along the Erie Canal from Buffalo to Albany could be most economically supplied in this way. That such would be the case in Westchester and elsewhere has already been determined by the commission.

At present New York State determines that the water to be supplied by any new system, or by any existing system from a new source, will be of proper quality. It apportions the water-supply resources of the state, and prevents the construction of unsafe structures in connection with such projects. It determines that proper provision has been made for the payment of damages. It may, under proper conditions, construct and operate coöperative water works. That is as far as we have gone at present.

Neither the Conservation Commission nor any other state board or official can order changes in an existing water-supply system except to make safe such dams as may be connected with it. Even though it be reported by the health authorities and proved by mortality statistics that the water supplied is unfit for domestic use, no state authority can by order compel the puri-

fication of the water or the abandonment of the source of supply. In this respect we have not gone as far as many states.

Although for a good many years we have had public service commissions with authority over transportation corporations, over gas and electric systems, both publicly and privately owned, and similar matters, the state has not yet assumed such jurisdiction over water-works systems. Rates, service, extensions, and the like are not regulated by any state board or official. Here again we have not gone as far as many states.

There has been for some years a demand that the power to regulate the rates and service of water supply systems be given to some state commission. Bills giving such jurisdiction to the public service commissions and to the Conservation Commission have on different occasions been passed by the legislature, but have failed to become law. There seems good reason to suppose that, unless there shall be an abrupt change in public sentiment on such matters, the state of New York will in the not distant future provide for more complete control of public water supplies by some state body.

DISCUSSION.

Mr. J. M. Diven.* The state of New York has entirely too much legislation and too divided a control of water supplies. By divided control is meant the control by the Conservation Commission, Public Service Commission, State Board of Health, Bureau of Labor Statistics, Bureau of Factory Inspection, and also the Comptroller's Department. As a water-works superintendent in the state of New York, the speaker frequently has to make reports to all of these bodies.

Bills have been before the legislature repeatedly, for the past few years, attempting to place the control either in the Public Service Commission, the Conservation Commission, or the Public Health Board. There seems to be a little strife among these boards as to which shall have this control. The speaker has appeared before legislative committees in favor of each of them; it makes very little difference which one has it, so long as it is

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one and only one. The water-works interests of the state will welcome public control; if it is proper control, it will help us in many ways, — in revising our rates, in establishing proper and uniform accounting systems, in securing appropriations for needed improvements, and in control of watersheds or filtration of water supplies. It is also the speaker's belief that it is a matter of sufficient importance to have a separate commission, or at least a separate division of some of the existing commissions, to take charge of sewage disposal and water supply, for sewage disposal and water supply should go hand in hand; they are too intimately connected to be in any way separated.

Speaking of the ninety days' time, our city was short of water last year. The rainfall was very deficient, and one of the sources of supply was short of water, and it was necessary to get water and to get it quickly. We went into the winter without the usual fall rains. The city was fortunate enough to have a reserve supply which had already been approved by the various commissions of the state, which was developed in a matter of a few days, tiding over our difficulties and giving the particular section in serious need a water supply through the winter. If we had not owned this supply, and had had to go to the Conservation Commission for permission to acquire or use it, and had waited ninety days, held hearings, and operated all the other machinery provided by the law, a large section of the city would have been without water during those ninety days. The supply was turned into the city mains just about forty-eight hours before the existing supply would have been exhausted.

Mr. Morris Knowles.* The author deserves our thanks for calling attention to one of the features of the large conservation movement which is so important and which is becoming of more and more consequence as the country grows and our population becomes more congested. The feature of the paper in which it is mentioned that there is need of apportionment of water resources is certainly one of moment, and one that all should consider. For it does not seem fair that the first company or city in a district should have the right to "prior appropriation," as it is called

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* Civil Engineer, Pittsburgh, Pa.

in the West, because that may bring about inequitable distribution of the water supplies of the state. There should be some central authority which shall look ahead into the future and study the possible growth of communities and the possible yields of various watersheds, and then apportion them in such a way that there shall be justice and fairness. That seems certainly a proper step in advance, and one that all states should emulate.

I was particularly struck with another portion of the paper, which referred to the fact that the commission in New York sometimes considers the need of giving permission to build competing systems. It seemed to me wholly inexplicable why such an emergency should arise. But a little later, and toward the close of the paper, we find the solution, namely, that while there is machinery in the state to govern the character of the water-supply service, as it affects the public health, there seems to be no provision now in the state of New York to govern or control the questions of adequacy and completeness of service, and fairness of rates of water companies, and those matters which do not affect the public health. These seem to be lacking; therefore, does it not suggest that if the state of New York had that sort of machinery there is absolutely no need for the duplication of capital, no reason for having a new investment and causing an old investment to become worthless? Is it not rather the better thing to compel the company, or whatever may be the corporate form of the agency, to give that service in a complete way and at just and equitable rates, and thus do away with the duplication of capital investment?

I was much impressed with the latter part of the paper, too which referred to the subject of coöperation. We have, as the author points out, that very fine illustration in the state of Massachusetts, where cities and towns seem to be able to get together, possibly not wholly from their own volition originally, but at least finally they were brought together, — and that sort of machinery is going to come, it seems to me, to be the thing in our country as the cities and towns grow, population becomes more and more congested, and it becomes necessary to deal fairly with these various communities, one with another. It is going to become necessary that peoples of different areas and views shall

sit down around the table, get together, and have metropolitan districts for various purposes.

While it may not be particularly germane to a water-supply association, I do want to call attention to the fact that this subject is simply one of the phases of the large movement of conservation, and that the streams of our country have many uses and that the water supply is not the only use. They even have that very humble use for the dilution of sewage in many cases, and they have the use for power, and the use for navigation, and the use for irrigation. So, when we are thinking of this movement of co-operation, we should think of it from a still larger and broader point of view, namely, to get out all the utilization that there is in running water for the several uses of different peoples and under different circumstances.

Mr. G. L. Watters. Mr. President, I should like to ask the author whether the act which gives the powers under which the Conservation Commission acts is at all similar to that in Pennsylvania which gives the Water Supply Commission of that state the right to pass upon the plans of any dam or any obstruction in a stream within that state, whether that obstruction is made for the use of public-water supply or whether it is made by an individual for an ice pond or by a large corporation which will procure its own water supply.

Mr. Suter. In this paper I have not attempted to cover all the engineering work of the Conservation Commission. We have jurisdiction over all the dams in the state that do not qualify as being less than ten feet high, on a watershed of less than a square mile, and impounding less than a million gallons of water. As that law was first passed, it applied to any dam on a stream, the minimum flow of which was greater than a certain amount, but that was too hard a criterion to apply, and it had to be revised. We have the right to inquire into the condition of existing dams, and have to pass on all plans, both for new dams and for the reconstruction of old dams, no matter what the purpose of the dam. We consider only the safety of the structure. It has nothing to do with the use of the stream at all.

I would like to state that that ninety-days' provision mentioned by Mr. Diven, I assume, was added for the protection of the

applicant, to keep the matter from being held up indefinitely. As a matter of fact, the Conservation Commission endeavors to enter a decision as promptly as possible. A certain amount of time of course has to be taken in any red-tape operation. The law requires us to hold a hearing and to publish a notice of that hearing in the newspapers. The newspapers in the smaller towns are published weekly, so that it takes a certain time to get started. After that we have to prepare our decision. I have known of a decision being prepared within an hour and a half after the termination of the hearing.

In regard to competition, Mr. Knowles hit upon and very happily expressed the reason why the commission has granted permission for the establishment of competing systems. When a municipality makes an application to install a water-supply system, and proves that the private system already in operation has pipes that will hold only twenty pounds' pressure, are too small to give fire protection, and there is not enough water any way, the pipes are dry a good part of the time, and when they have water it is bad, considering that the state has no power to require any changes whatsoever in that system, the Conservation Commission has been unable to find that public necessity did not exist for a good, adequate system for furnishing water, and has granted applications on that consideration. If the commission had been able to tell the existing company to do this, that or the other, and make it do it as it ought to have the power to do, it might be different. Of course I do not imagine that any of us really believe in the duplication of a proper water-supply system with the resulting loss of invested capital.

Mr. Watters. May I ask if it is necessary for any individual, corporation, or municipality to make application to the Conservation Commission before beginning the work of constructing a dam or any obstruction in a stream, supposing it to come within those requirements of ten feet and one square mile and so on, and is there a penalty if it is not done?

Mr. Suter. Yes, it is necessary, and there is a penalty if it is not done.

THE LOCATION OF LEAKS IN SUBMARINE PIPE LINES.

BY ELMER G. HOOPER, ASSISTANT ENGINEER, DEPARTMENT OF WATER SUPPLY, GAS, AND ELECTRICITY, NEW YORK.

[*Read September 7, 1915.*]

In connection with the maintenance of the distribution system of a large seaboard city, a great many varied problems arise, some of which require special treatment. One among them is the detection and location of leaks on submarine pipe lines supplying islands or areas isolated from the main system by rivers or channels.

Detection of leakage on such lines is comparatively simple, but the location of them is an entirely different matter. Any of the usual means of measurement fitted for the size of main, with perhaps special arrangement for large mains, will determine the presence and size of leak if simultaneous readings are taken on both sides of the stream.

Several points should be noted which have a bearing on the problem of leak location and which affect the method to be used for such location. Owing to the expense attached to the examination and repair of submarine pipe, it is not worth while to do anything with them unless the amount of water going to waste is worth more than the probable expense, or the pressures in the area supplied are materially reduced, or serious damage is anticipated from a continuation of the leakage.

In general, the above considerations would limit the complete investigation to leaks of such size as would make applicable the following method, which has been used in New York City on a 12-in. crossing from Rikers Island to North Brothers Island, and is considered sufficiently successful to warrant making preparations for its use on other river crossings.

Where the velocity of water in a main due to the leak is two feet per second, a perfectly good gradient consisting of two distinct slopes can be obtained. At the point where the slope of gradient changes, is the point where the velocity changes and hence where the waste occurs.

To determine this gradient it is necessary to have the pipe coefficient as accurately as possible, to have the flow at the supply and the discharge ends of the submarine pipe, the pressures, and elevations at which pressures were taken on both ends, and the distance between pressure points. Flow measurements and pressures ought to be taken simultaneously. Pressure gages should be accurate and of such graduation as to easily estimate to tenths of pounds.

The specific case of the above-mentioned crossing between Rikers and North Brothers Island will best illustrate the method.

Some time during the month of July, 1914, a decided drop in pressure on North Brothers Island was reported to the department and an urgent request made to have conditions improved. The district repair gang found after valve operation that the trouble was on the 12-in. crossing from Rikers Island to North Brothers Island, this stretch of pipe being a section of a loop from the mainland at Barretto Point to Rikers Island to North Brothers Island and on through a 6-in. to the mainland at 140th Street. Orders were issued to the Water Waste Division to determine, if possible, the location of the break, because North Brothers Island with its hospitals was under these conditions dependent upon the one inadequate 6-in. line. A party was sent out at once and carried through the investigation with satisfactory results in a couple of days.

As no pipe coefficient was available, it was necessary to determine one for a line of similar size and under similar conditions. It was obtained at Barretto Point on the Rikers Island line. With the valve closed on the North Brothers Island end of the broken line, a pitometer placed in the 12-in. line at Barretto Point measured the leakage plus the Rikers Island consumption, then, with valve on the Rikers Island end of the broken main closed, measured the island consumption alone. The difference gave the leakage for that height of tide. As soon as possible, then, pressures were taken simultaneously on hydrants located near each end of the flexible pipe. Hydrant elevations and distance were obtained by level and transit respectively, distance being checked roughly from a government chart. The coefficient in Chezy formula was then determined for the Barretto Point section where a flow was con-

stant throughout its length. Applying the pipe coefficient to the broken section, the slope of the gradient up to the leak was found. Since the valve at the North Brothers Island had been closed, there was no flow beyond the leak, hence a flat gradient obtained from the leak to that point. After figuring the gradient elevation at each hydrant and plotting the gradient to scale, the distance of the leak from the hydrant at North Brothers Island was determined as approximately six hundred feet.

To check the figures an attempt was made to find the leak by sound. An engineer using an aquaphone with an oar placed in the water was taken in a boat and by means of stadia and transit directed to the point near where leak was supposed to be. The sound could be distinctly heard even though the depth was about twenty-five feet. On a circumference of one hundred foot radius, approximately, the sound became indistinct. As found by the diver, the break was 570 ft. instead of 600.

It is possible, we believe, to locate such leaks at least as closely as within thirty feet, and often closer, if pipe coefficient is accurately determined for each crossing and corrected every few years as the pipe ages.

TESTING METERS WITH REFERENCE TO CURVES OF ACCURACY AND FRICTION LOSS.

BY FRED B. NELSON, ASSISTANT ENGINEER, DEPARTMENT OF WATER SUPPLY, GAS, AND ELECTRICITY, NEW YORK.

[*Read September 8, 1915.*]

The New York Water Department is now making investigations looking toward more scientific and definite requirements in regard to meters, including the practicability of specifications on material and design; the establishment of a definite rate basis for testing meters to replace the present vague size-of-stream method, with that representing reasonable requirements; and the inclusion, in approval tests, of the determination of the curve of pressure loss at varying rates of flow as having an important bearing on the general efficiency, service, and durability of the design.

The writer feels that it would be out of place at this time to go into detail as to the methods to be adopted to meet the New York conditions as an outcome of this investigation, but desires rather to call attention to one or two features, more or less general, in present meter-testing procedure which it is hoped may be improved in fairness to the consumer, the municipality, and the meter companies.

The matter of specifications for meters is one which, if taken up at all, requires long and careful study in order to write specifications which will definitely *specify* without interfering with a desirable exercise of resourcefulness in design by the meter companies, backed by their experience in meeting and overcoming difficulties.

The testing of meters on a rate basis it is believed will meet with the general approval and preference of all concerned as being a definite, intelligible method, as against the haphazard size-of-stream procedure, a true conception of which can only be gained by an attempt to determine the rates corresponding to the various sizes of streams being used as per schedule. Such a determination has been included in the course of the investigations in this city,

from which it is learned that the variation, especially on field tests, is too great to represent anything like uniform testing, the wide range in rates being, of course, due to variation in street main pressure, size and interior condition of service pipes, friction loss in meters of the same size but of different makes and conditions, variation in length, size, and layout of hose and fittings from a meter in place to the test meter on different tests, etc.

A rate schedule should be made up with reference to the char-

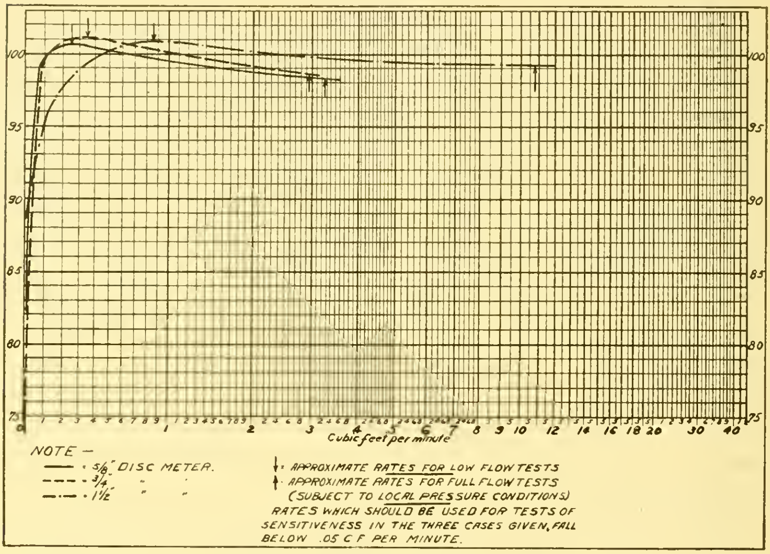

Fig. 1.

Typical accuracy curves for disk meters illustrating rates at which tests should be made to define the curve of the individuall meter.

acteristic accuracy curve of the individual size and type of meter. Such a curve for disk meters (Fig. 1) rises abruptly from a low registration at the minimum operating flow to a maximum at low flow. From this point the per cent. of registration for nearly all makes of meters decreases slightly as the rate increases to a point at maximum rate which may be one or two per cent. below the maximum registration. The accuracy curve of a meter may be defined by a test that includes the two rates, — one at the point

of maximum registration and the other at full flow. There should then be included in the test a third rate — constituting a test of sensitiveness — at which a meter in proper condition should operate.

When a rate schedule is established, it is proposed to control the rate on field tests by means of an apparatus including in general a set of calibrated orifices through which the water may be discharged under a difference of pressure shown by attached gages and regulated by a throttle valve, the size of orifice being selected by the operator with reference to the rate desired, the plotted or tabulated discharge of the orifices at varying pressure, and the available static pressure. With the rate thus adjusted, a test would be started and stopped with a cut-off valve in the ordinary way.

The question of pressure loss in a meter is one which is ordinarily considered as of secondary importance, accuracy being the accepted prime requisite of the apparatus. It would seem, however, in this age of efficiency and economy, that, other things being equal, preference should be given to the measuring device which consumes, for operation, the least amount of the pressure energy which the pumping station supplies and the system is designed to conserve. On the ordinary service, the meter usually consumes approximately from 25 per cent. on small sizes to 90 per cent. on large sizes of the total loss on the service. The pressure loss due to the meter is, therefore, an item of the total loss and one to be equally considered with that of size of tap and service.

An apparatus so constructed that the water in passing through will displace a well-fitted piston or disk with the motion of the latter transmitted to a registering dial might of necessity constitute a measuring device that would meet the requirements of the ordinary accuracy test. A water meter, however, that combines a high degree of sensitiveness, durability, and accuracy with a minimum of pressure consumed in operation requires careful and expensive investigation, design, and manufacture.

The feature of pressure loss is one that is tangible, easily determined, and definitely comparable with fixed standards, and as one which affects the consumer and the water department, it should be considered in approval tests, and the efforts of the meter

companies in perfecting their design to meet high standards should thereby be recognized.

The ignoring of friction loss or its reciprocal feature — capacity — has resulted in the low capacity meter gotten out in inferior sizes by the meter companies to meet the competition under requirements which have included accuracy only. In the case of 2-in. disk meters recently investigated by the New York department, it was found that 75 per cent. of the 2-in. meters being delivered to consumers were of the low capacity type, and inquiry in six cases at random showed that the purchaser had no knowledge of high and low capacity, simply specifying 2-in. meter and taking what his plumber delivered. In one of these cases the complaint of low pressure called for an investigation by the department, which revealed the fact that two 2-in. low capacity meters set in parallel were responsible for a drop of 6 lb. in pressure at the time of maximum draft. This loss could have been reduced to only 2 lb. under the same rate had full capacity meters been installed, which would

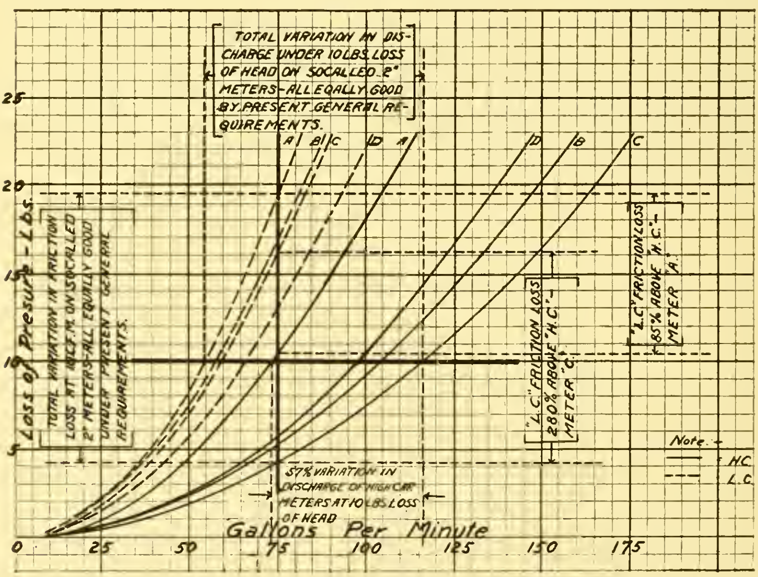

FIG. 2.

Comparative loss of pressure and capacity. Four makes of "high capacity" and "low capacity" 2-in. meters.

have obviated complaint and saved investigation; or, conversely, full capacity meters under the same loss of head in the meter would have delivered nearly twice the existing maximum draft.

In regard to the question of capacity, tests were made to determine curves of friction loss at varying rates of flow on high and low capacity 2-in. meters and 1½-in. meters of those makes which included two capacities of the one size.

These tests showed a friction loss in the low capacity meters (Fig. 2) varying from 85 per cent. to 280 per cent. above that in the high capacity, the discharges under 10 lb. loss of head on the high capacity being from 35 per cent. to 90 per cent. above the low capacity, while the discharge of the different makes of the 2-in. full capacity type varied by as high as 57 per cent. Curves of friction loss determined on other meters show a wide variation between different makes in the same size and type.

Comparing the data furnished by the meter companies as to capacity of disk meters (Fig. 3) it may be noted that under a 10-lb. loss of head the variation of discharge on the same sizes of different makes is as high as 97 per cent., and averages 64 per cent.

On fire line meters and compound meters the curve of friction loss is also a guide as to the rates which should be used in testing. The curve usually shows a " change point " at a low rate — somewhat subject to pressure conditions. At this point a fluctuation in pressure loss and accuracy is to be expected, and this rate should be avoided in the test. The rates used should be those schedules for each of the meters included in the design.

In connection with the recent investigations along these lines, a number of tests have been made to determine curves of accuracy and friction loss, in all of which the procedure and apparatus used has been essentially the same. The rates were obtained by actual weight of the quantity of water passed, the time being determined by stop-watch. The loss of pressure was determined by measurement of the deflection of mercury in a 6-ft. U-tube connected by rubber tubing to 8-in. sections of the testing machine above and below the meter. The pressure loss was computed from the deflection of mercury, using mercury at a specific gravity of 13.6 minus 1 for the equal column of water in the other leg of the tube. The mercury U-tube gives very consistent results, eliminates

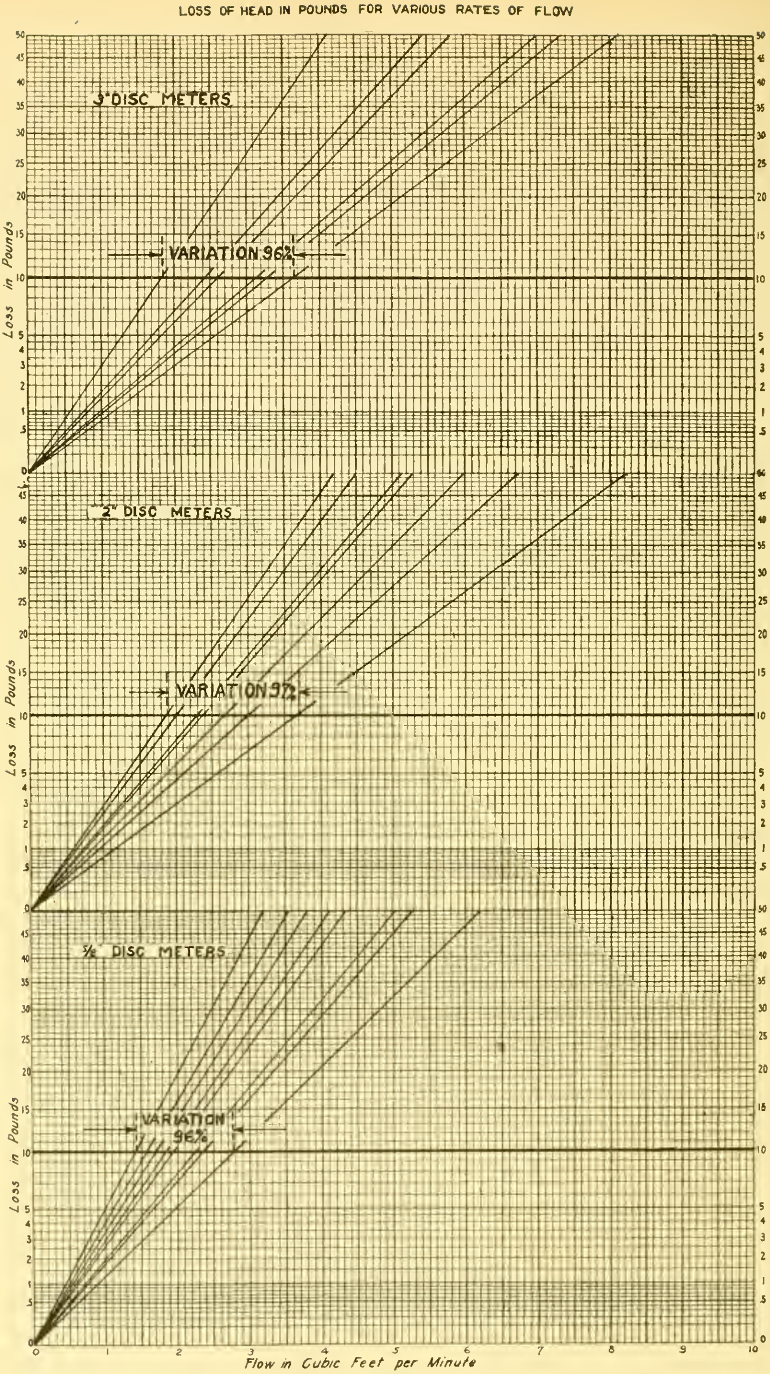

FIG. 3.

Illustrations of variations in discharge on different makes of meters of corresponding sizes under pressure loss of 10 lbs. (Taken from data supplied by individual companies.)

gage errors and errors due to attempts to compare and subtract the simultaneous readings of two gages, and has an especial advantage on low friction loss, as $\frac{1}{16}$-in. or $\frac{1}{8}$-in. deflection is very definite, while the corresponding .3 or .6 lb. of pressure difference would be indeterminate with ordinary pressure gages. The 6-ft. length of tube is sufficient for measurement of pressure differences up to 32 lb.

THE BROOKLYN WATER SUPPLY.

BY WILLIAM F. LAASE, ASSISTANT ENGINEER, DEPARTMENT OF WATER SUPPLY, GAS, AND ELECTRICITY, NEW YORK CITY.

[*Read September 8, 1915.*]

The catchment area from which Brooklyn derives its water supply is located along approximately the southerly half of Long Island, extending from Gravesend to the Suffolk County line, or a distance of about 35 miles, and from about one-half mile north of the southerly shore line to the summit of the ground-water table, which is located a short distance to the south of the ground surface divide or backbone of the island. The watershed area within these limits comprises about 200 square miles. The underlying strata are mainly of coarse sands and gravel several hundred feet in depth with one or more intermediate clay beds.

The rainfall percolates slowly downward through the sands to the saturated sand bed, and thence generally southerly toward the bays or ocean along the south shore. There is also a comparatively small flow of the ground water into the streams which during rainfall periods receive direct accessions from the rain. This slow-moving body of water has a downward slope of about 12 ft. per mile in a southerly direction from the ground-water summit, and its upper surface is commonly referred to as the "ground-water table."

The collection system is located in the southerly portion of the catchment area, about one-half mile north of its southerly limit; practically the entire ground-water flow and stream flow is thereby intercepted.

Ten surface streams are utilized, of which number eight flow by gravity into the conduit system and two are pumped. In addition, there is one storage reservoir with a content of about 880 million gallons, which furnishes a gravity supply into the conduit system and which is held in reserve. Twenty-seven pumping stations obtain their supply from the ground-water flow, of which number twenty-five are driven well stations and two are infiltra-

tion galleries. Four of these stations deliver their supply directly into the distribution system and twenty-three deliver into the conduit system. All water delivered into the conduit system is pumped into high-level reservoirs, from which it flows into the distribution system.

There are about 975 wells, varying in depth from about 30 ft. to about 325 ft., and in size from 4.5 in. to 24 in. In general, the wells are of the iron-pipe type with solid brass strainers. Some are of the slotted vitrified pipe type, varying in diameter from 6 in. to 18 in., with a maximum depth of about 50 ft. The wells deeper than 90 ft. penetrate one or more blue clay beds and they are driven by means of a well driving machine; after the pipe has been driven to the depth desired, about 20 ft. of brass strainer with a short length of plain brass pipe and lead packer at the top is lowered into the hole; the casing is then pulled back, thereby leaving the strainer exposed to the water-bearing sand and gravel; the lead packer is then expanded, thereby sealing the annular spaces between the strainer and the outer casing. Many of the shallow wells are also of the iron-pipe type with solid brass strainers; these wells are placed by sinking larger casing to the desired depth, by the weight and bucket method; after all material is removed from within, the strainer with pipe attached is lowered; then as the larger casing is withdrawn, the annular space is graveled.

The two infiltration galleries have a total length of about 6 miles, and are composed of vitrified pipe with socket, in 3-ft. lengths, varying in size from 20 in. to 36 in. The pipes are laid with open joints about 10 ft. below the ground-water table to a grade of .04 in 100 ft. toward a central pump well, located about midway in each gallery, from which the water is pumped into the conduit system.

Owing to the water waste campaign during the past three years, it has been possible to discontinue the use of six driven well stations and one stream of those previously mentioned, representing a saving of about 18 million gallons daily, and to furnish about 7 million gallons daily to the borough of Queens from the remaining sources of supply.

The following shows the actual average cost of the wells based on materials, and teams for hauling same from headquarters to

site of work, exclusive of overhead charges, laborers at $2.50 per day of eight hours.

8-inch deep well, 200 ft. deep	$3.07 per foot
6-inch shallow well, 60 ft. deep	4.71 per foot
8-inch vitrified well, 50 ft. deep	2.82 per foot
12-inch vitrified well, 25 ft. deep	7.00 per foot

The first two are of wrought-iron pipe with 20 ft. of brass strainer.

DISCUSSION.

MR. ALEXANDER POTTER.* The procuring of water supplies by means of infiltration galleries is not commonly resorted to. Even where the use of infiltration galleries promises to yield good results, engineers often hesitate to make use of them because of the many failures recorded, the causes for which either are not understood or when understood have not been brought to the attention of the engineering profession.

The proper design of an infiltration gallery should not be at all difficult, for the process which takes place in an infiltration gallery is duplicated in nature by the diffused seepage of the underground waters into surface streams. This ground-water seepage maintains the flow in surface streams long after the direct effects of the rainfall have ceased. The fundamental laws governing the ground-water flow of surface streams are fairly well understood and apply with slight modifications to infiltration galleries. They may be stated as follows:

1. The ground-water stream flow is fixed and limited to the surplus underground waters accumulating and stored in the valley.
2. The rate of seepage varies with the transverse hydraulic slope of the ground-water table and the porosity of the material through which the ground water flows.
3. When the hydraulic slope is not steep enough to discharge the surplus ground waters as fast as they collect in the valley, the ground-water table rises until equilibrium is established, and vice versa if opposite conditions exist.
4. Except as affected by the seasonal changes of the rising and lowering of the ground-water level, the ground-water stream flow is constant.

* Consulting Engineer, New York City.

There is no reason why the seepage of ground water into an infiltration gallery under proper conditions should not be equally as dependable as the identical natural process of ground-water seepage into surface streams.

An infiltration gallery may derive its supply of water from two distinct sources: A supply derived by intercepting the surface underground waters which were under natural conditions joining the surface waters by diffused seepage, and a supply derived by infiltration from bodies of surface waters adjacent to the infiltration gallery. It appears that many infiltration galleries derive by far the larger portion of their supply from the second source. A carefully made scientific investigation will in nearly every case reveal within quite narrow limits the quantity of water available for an infiltration gallery from the two sources above mentioned, and as long as the draft does not exceed the available supply there is no reason why the yield of a properly designed infiltration gallery should gradually decrease with time, as is only too often the case. The recorded failures of infiltration galleries can, in the writer's opinion, be largely attributed to the erroneous assumption that a pipe laid below water level with open joints or perforations and surrounded by a porous material will continue to deliver the volume of flow developed when first constructed, ignoring entirely the fundamental law of supply and demand.

This is not true with infiltration galleries constructed on the floor of an impervious strata intercepting the transverse ground-water flow in a pervious strata of coarse sand immediately above. Under such conditions, infiltration galleries have been very successful. A typical example of such a gallery is the one constructed at Munich, Germany.

Under conditions other than that just stated, and where the supply appears to be adequate, there is often noted a gradual breaking down of the infiltration gallery, apparently due to the silting up of the filter media immediately surrounding the gallery. Under the natural conditions of ground-water seepage into surface streams, no such silting appears to take place, and when such silting up occurs in connection with an infiltration gallery, it can only be due to the peculiar ground-water conditions set up by construction of the gallery. The writer believes that the silting

phenomena are primarily due to the high velocities of the ground water through the filter media immediately adjacent to the gallery, velocities so great that the finer particles of soil are transported to the gallery, gradually clogging the interstices in the filtering media and the gallery proper. This phenomenon of clogging is aggravated by the lowering of the ground-water level in the vicinity of the filter gallery below the top of the gallery. For a definite yield, as the wetted perimeter of the gallery decreases, the entrance velocity increases in inverse proportion. To attempt, therefore, to force an infiltration gallery to the extent of lowering the ground-water table below the top of the gallery, will tend to increase the danger from clogging and materially shorten the life of the infiltration gallery, especially when constructed in the finer sands.

With tubular wells, the question of high entrance velocity in the filtering media surrounding the well screen is not of equal importance; wells are comparatively short-lived, and when clogging does occur it can be remedied by back-flushing or other known methods. No such remedies are available for clogged infiltration galleries. When properly designed so that the yield of the gallery does not exceed the supply available from the surplus underground waters and the supply derived by infiltration from a nearby body of surface water, and the entrance velocities are sufficiently low so as not to transport the finest soil particle, the useful life of the infiltration gallery should be practically unlimited.

The yield from an infiltration gallery constructed in the finer sands should be automatically controlled so that it cannot exceed a certain predetermined amount, in order to prevent the lowering of the ground-water plane below the top of the gallery, so as to keep the entrance velocities within safe limits. This condition can best be secured by restricting the flow from the gallery to an amount which will keep the gallery constantly full of water for its entire length.

In many cases the requirements as outlined herein will for a given yield call for the construction of much longer lines of infiltration galleries, constructed in finer sands than has been the practice in the past, so that in many instances other methods

of supply will be found to be more economical. Throughout the country, however, deposits of gravel and sand exist in the valleys of rivers and along lakes and seacoasts, in which infiltration galleries can be economically constructed to yield adequate supplies either from the surplus underground waters or from the water derived by infiltration from adjacent natural and artificial bodies of water, or from both sources. The successful results on Long Island show the maximum possibility of such a supply.

In tropical countries, where there exists so strong a prejudice against the use of stored surface water for a public water supply, due to the deterioration resulting from the luxuriant vegetable growth abounding in such waters, the use of an infiltration gallery is often advisable. The natural purification which takes place in the water while passing from the surface reservoir to the infiltration gallery has been found to be effective. The ability to economically produce a good, clean potable supply even from a very inferior raw water by double filtration, or by other methods, has not been generally recognized. It appears that ground waters are largely preferred, and the proper use of infiltration galleries alone or as a supplement to a well supply is an important matter.

Mr. Walter E. Spear.* Some seven or eight years ago, when the Board of Water Supply of New York City was investigating the possibilities of developing a large ground-water supply in Suffolk County, Long Island, I had occasion to look into the Wantagh and Massapequa infiltration galleries of the Brooklyn works which Mr. Laase has described, and I am very glad to confirm his statements of the success of these works. The geologic conditions where these galleries were built were very favorable for this type of construction. The uniform yellow gravels, which carry most of the southerly flowing ground water, have there but little depth, and the gray sands and clays beneath are practically impervious, conditions favorable to the collection of a supply by means of galleries which cannot be economically constructed far below the ground-water surface. These galleries were necessarily built on land previously purchased for other purposes and were, therefore, located rather close to the salt waters of the south

* New York.

shore of Long Island. Heavy pumping from wells on the same location might have drawn in salt water, but the galleries, placed as they were, not far below sea level, were entirely safe from such infiltration. Another favorable circumstance is the absence of much iron. I think the Department of Water Supply has had no trouble from clogging of the galleries due to this cause. In Europe such trouble has occurred, and I know of several instances where the galleries have given place to wells.

One serious objection to the infiltration gallery is that it does not provide any storage if constructed, as were these galleries, at an economical depth below the ground-water surface. The normal depth of the water over the Wantagh and Massapequa galleries is something like 10 or 15 ft., which is diminished rapidly as soon as any draft occurs. After the water is drawn down within a few feet of these galleries, but little storage is left to draw upon. On the other hand, in a water-bearing formation of some depth, favorable to well development, a well can readily be driven such a depth that by pumping down the ground water a large amount of storage becomes available. Such conditions are not found where the Wantagh and Massapequa galleries are constructed, but farther east on Long Island, in Suffolk County, good material is found to a depth of 100 ft. or more, and the possibilities of developing ground-water storage are great. In that district it would be a serious mistake, for the reason just given, to construct infiltration galleries. As for the comparative cost of water from a system of wells and from infiltration galleries, the greater cost of operating the wells largely offsets the much larger first cost of constructing the galleries. Considering a well-designed gallery permitting access for inspection or repairs, the advantage in cost of these supplies is in favor of the wells.

Mr. Laase (*by letter*). The writer offers his apology for his very meager paper, for it was not his intention to go deeply into the subject because of the lateness of the hour. He extends his thanks to Messrs. Potter and Spear for their opportune discussion. He would, however, like to add that on the Brooklyn watershed, west of Rockville Centre, where there are only driven wells, the unit yield per square mile of watershed area is almost double that where there are only infiltration galleries east of Rockville Centre.

This is necessarily so because the galleries merely intercept the ground-water flow above the first clay bed, which is approximately 40 or 50 ft. below the surface of the ground at the gallery, whereas the wells which penetrate one or more clay beds intercept the flow of a greater depth. There can be no doubt, then, that with long, well-designed suction lines and a sufficient number of wells connected thereto, more water will be obtained than through the infiltration gallery of the same length; and it is believed that the well system will be the more economical in the end.

GRUBBING A LARGE RESERVOIR.

BY GEORGE A. WINSOR, M.AM.SOC.C.E.

[*Read by title, September 9, 1915.*]

Early in August, 1914, work was commenced grubbing around the shores of Kensico Reservoir, a part of New York City's new Catskill water supply. The land taken for this reservoir comprises some 4 470 acres, and as the water will cover about 2 218 acres, there will be marginal lands of about 2 252 acres. The contractor is required to clear the site of the reservoir to a line 30 ft. outside of the flow line, which is about twenty-seven miles in length.

Under the specifications, grubbing shall include all designated areas within the 30-ft. margin of the reservoir, the reservoir bottom wherever the depth below the flow line is 35 ft. or less, and other areas wherever ordered. The grubbing consisted of the removal of all stumps and roots larger than 2 in. in diameter to a depth of 6 in. below the surface of the ground, and all holes left after grubbing the margins of the reservoir and its bottom to a depth of 10 ft. below the flow line had to be satisfactorily refilled. The areas paid for were the designated areas grubbed, except that no area could be estimated for payment as having a less area than 1 000 sq. ft., or a less width than 20 ft.

All areas to be grubbed were designated on the ground by actually staking them out in advance of the work as follows: The limit of clearing was staked by measuring 30 ft. horizontally above the flow line at elevation 355; then the elevation 320 contour 35 ft. below the flow line was staked, and with these lines marked on the ground the field party was able to locate most areas with a tape only so they could be platted in the field on the topographic plans, 100 ft. to the inch scale, with the additional information already on these plans, such as boundary walls, highways, building foundations, fences, water courses, etc.; if there were no natural features which could be identified in the maps, the area was located by stadia and subsequently plotted.

The principal natural timber growths around the basin consist of oak, maple, whitewood, birch, hickory, elm, locust, ash, dogwood, cedar, chestnut, and many fruit trees of different kinds. The chestnuts had been killed by the "bark disease."

Most of the clearing on the areas to be grubbed was done during the years 1910 and 1911, and the stumps of the trees were cut off close to the ground; for this reason the old method of pulling the stumps with a stump puller of capstan type, pulling the stump with the tree as a lever, using a block and fall, or the use of the caterpillar traction engine as used at Ashokan Reservoir, were not adapted to the work here.

The grubbing was sublet by the reservoir contractor, and a portion of it was again sublet. The method employed by the subcontractors was as follows: All small stumps from 2 in. to about 5 in. in diameter were grubbed by hand, using axes and mattocks, and all sprouts were cut off of the larger stumps, which were then removed with the aid of an explosive. Sixty per cent. dynamite was used most of the time, the quantity depending upon the size of the stump, variety of tree, and the quality of soil around the roots.

Many areas covered with a thick growth of small locusts were encountered; these were pulled with a pair of horses or yoke of oxen with a chain hitched around the tree; usually a little grubbing was done on one side only. This proved to be a very effective and rapid method for removing this species of trees when not too large.

The contractor usually worked about three weeks after a monthly estimate on the grubbing and blasting, as he found it required the remainder of the month to clean up and burn the brush and stumps before his next succeeding monthly estimate.

Work was carried on through the winter months with very little interruption, it being a very mild winter with but little snow; during the spring months, which were very dry, the contractor was forbidden building fires because of the fire hazard to city property adjacent to the clearing limits. He continued with the grubbing operations and burned the stumps later when the grass was green and the weather suitable.

The grubbing was practically completed in August, 1915, thus

requiring thirteen working months to grub a total of 502 acres. The maximum amount grubbed in a month was 70 acres, in the month of June, 1915; the average amount grubbed per month was 39 acres, but the quantity of labor varied during the progress of the work.

A daily record was kept of the dynamite used by the contractors for the estimate months, and the quantities used per acre have been computed and may be of interest:

Maximum dynamite used, September, 1914	170 lb. per acre
Minimum dynamite used, January, 1915	44 lb. per acre
Average dynamite used, for entire work	95 lb. per acre

The largest timber growth in the basin was grubbed during the month of September, 1914, as indicated by the quantity of explosive used, while during the month of January, 1915, small stumps were grubbed.

It was further demonstrated that it required less explosive to shatter a stump when the ground was frozen than when there was no frost. In the former case very little earth was disturbed by the blast, while in the latter case a large hole was made. A hole was made in the ground with an iron bar, and the explosive was placed under the stump; fuse exploders were always used.

The contract price for grubbing, which included refilling holes, disposing of stumps and brush, and all expenses incidental to the work, was $100 per acre.

In conclusion, the writer believes that the method employed in doing this work was the most economical and the best, under the circumstances. However, had it been possible to do the clearing and grubbing in one operation, the latter would have cost the contractor less, as there would be a considerable saving in both labor and explosive if one of the other mentioned methods had been employed.

LEADITE JOINTS FOR WATER PIPES.

BY HENRY A. SYMONDS, CONSULTING ENGINEER WITH HANSCOM CONSTRUCTION COMPANY, BOSTON, MASS.

[*Read September 7, 1915.*]

The use of Leadite for pipe joints seems to have been attended with widely conflicting experiences. Many of the contractors and town and city water departments have met with disappointing results in its use, while, on the other hand, it has a large number of enthusiastic advocates.

The writer knows of no way to handle the subject except by cumulative testimony of actual experiences, and wishes to acknowledge receipt of valuable information relative to Leadite from Mr. George McKay, Jr., of the Leadite Company; Mr. C. P. Cook, Dover, N. J., Water Department; Mr. Frank A. Marston of the firm of Metcalf & Eddy, consulting engineers; Mr. Harry C. Lyons, deputy water commissioner, Department of Public Works, Buffalo, N. Y.; Mr. Lincoln Van Gilder, superintendent water works, Atlantic City, N. J.; Mr. W. C. Hawley, chief engineer and general superintendent Pennsylvania Water Company; Mr. John Palmer, general contractor, Boston, Mass.; and Mr. H. E. Aherns, of the Reading Contracting Company.

Leadite was tested by the manufacturers in the ten years from 1894–1904, and the company, being satisfied that it had finally perfected the process of manufacture and the proper composition, put it upon the market in the latter part of 1904.

The first actual use of Leadite in public works is reported by Mr. Lincoln Van Gilder, it being used by Mr. Kenneth Allen, superintendent Atlantic City water works, in 1903, and its use has been continued by Mr. Van Gilder with very favorable results up to the present time. No sign of deterioration has appeared in any instance in that city, and the joints seem to be uniformly watertight. To quote Mr. Van Gilder further:

"The percentage of bad joints compare very favorable with

lead under the best conditions, and with close or wet joints the difference is decidedly in favor of Leadite."

Used in Atlantic City in sandy soil, much of it below ground water, Leadite worked very favorably in the wet ground where molten lead could not be used. Seepage was noted in the newly poured joints, but this entirely disappeared in a few days.

Mr. C. P. Cook used Leadite first in 1907, and has used it continuously since that time in the Dover, N. J., water works, under pressures varying from 20 to 180 lb., without having had a bad joint and no signs of deterioration.

The experience of Metcalf & Eddy, who were among the early water-works men in New England to become interested in Leadite, is well outlined in the following letter:

" Leadite was used on construction work under our supervision for the first time in 1909, at Concord, Mass., on the Nagog Pond 16-in. pipe line. In this contract it was optional with the contractor whether lead or Leadite should be used, and the contractor chose the latter as offering some advantages on account of the wet character of the ground through which the pipe was laid for a considerable distance. The specifications stated in considerable detail the method to be used in handling the Leadite, and special care was exercised during the construction work to assist the contractor as far as possible in obtaining good joints. The laborers were without experience in handling this material, and had some difficulty at first in heating the Leadite to the proper consistency, but after a little they became fairly proficient. Some of the joints were tested during the progress of the work, and the results were for the most part satisfactory. If the writer remembers correctly, it was necessary to cut out a few joints and repour them, owing to the cooling of the Leadite before the joints were sufficiently filled. As far as we have been able to ascertain, this pipe line has caused no particular trouble, and there is no indication at the present time that the Leadite joints are in anything but satisfactory condition.

" In 1912, under a contract with the Milford Water Company, Milford, Mass., for the Purchase Street pipe line, the contractor also chose to use Leadite for the pipe joints. As in the previous case, the laborers experienced considerable difficulty in handling the Leadite, especially in getting the material hot enough to be of the right consistency when the ladle reached the pipe joint. Several hundred feet of 8-in. pipe were laid with this material, and upon test it was found that a large percentage of the joints

leaked drops of water, while some of the joints actually leaked streams of water. The leaks were observed for a week's time, and it was found that the quantity of leakage gradually diminished in nearly all of the joints, so that the majority of the joints at the end of the week were apparently satisfactory. Some of the jointing material was cut out and the joints repoured, where the worst leakage occurred. By this time the contractor had spent so much time and care, and there still seemed to be so much uncertainty as to the action of the material, that he gave up using Leadite and went back to lead joints as being much more satisfactory. Whether or not the Leadite purchased in this particular case was of inferior quality to that used at Concord, we are unable to state, but in spite of great care the results were not nearly as satisfactory, and were, in fact, very disappointing.

"In private work we know of two cases where water-works superintendents are using Leadite under their personal supervision, with men trained in its use, and are obtaining satisfactory results, with a material saving in cost of jointing material.

"In view of the above experience, and after making certain tests and observations, we have omitted the use of Leadite in all specifications for municipalities, on the ground that it is an uncertain material in inexperienced hands, and where contracts are liable to be awarded to inexperienced or unreliable contractors, it seems to us unwise to allow the use of this material.

"Our experience has been that under such conditions the contractor charges the same price for Leadite as for lead, so that there is no saving to the municipality in allowing the use of Leadite, and there is hazard in the uncertainty as to whether or not the joints will be watertight. If the joints are not watertight it is a difficult matter to remedy the trouble, and an exceedingly difficult matter to persuade a contractor to cut out and repour the joints in several hundred feet of pipe line, to remedy the leakage.

"We are confident that in experienced hands, and under favorable conditions, Leadite can be used satisfactorily and with a material saving in cost, but under the conditions above mentioned we believe that it is neither advisable nor economical."

Mr. Henry L. Lyons, of Buffalo, writes that he used Leadite in about seven hundred feet of 6-in. pipe joints in 1905. This has been watched since, and has remained perfectly tight, a leak never having occurred, although Leadite has not come into general use in the Buffalo system.

Mr. John Palmer, general contractor, has used Leadite in one or two instances in Massachusetts towns, but is not satisfied with

the results, and has abandoned its use. The difficulty he experienced was in satisfying the authorities that the joints which showed seepage at the start would become tight and be satisfactory.

In 1911, the Hanscom Construction Company, of Boston, made a contract to build a complete water plant for the Barnstable Water Company at Hyannis, Mass. The contractors requested the privilege of using Leadite in the 16-in. supply line running two and one-half miles from the standpipe to the village of Hyannis, agreeing to keep open the joints until it was determined what the result would be, and removing such joints as proved defective. The consent was given, and the program was carried out. The writer, as engineer for this work, gave close attention to the method of melting and pouring Leadite and watched the joints closely after water had been turned on, which it was impossible to do for some weeks after the line had been laid. Water was then pumped to the top of the standpipe hill by a small pump connected into a blow-off, and the pipe was kept full intermittently for the next three months; during the period of the construction of the standpipe foundation, and the erection of the tank, the pressure varying from zero to 40 lb.

The first results were disappointing. We had been informed by the Leadite Company that the joints would leak for a few days, possibly a week, but the week came to an end and there was no sign of reduction. We waited rather impatiently another week, at the end of which time the joints were still flowing rather freely; in many places small spurts were noted. We then called for the Leadite Company to inspect the work and tell us what to do. They looked over the joints and advised us to let them set for a time longer. We had been continuing the use of Leadite in laying mains in other parts of the town where it was not possible to keep joints exposed. At the expiration of the third week, as the joints still leaked, it was decided unwise to continue, and we ordered the use of all Leadite stopped at once, and all further joints in the system made with lead, which was done. The leaks showed a marked reduction at about the end of the fourth week, so much so that they were eventually filled in, although they were far from tight, and even puddled the trenches to a slight extent. While no exact record of time was kept, it was probably about six or eight

weeks before we were able to dig up joints and find tightness, but the interesting part of this was that it was real tightness; the joints were dry. We could not find so much as a drop of leakage anywhere along the pipe line, and perfect tightness has continued since.

A few months later, the company received a contract for laying about twelve miles of cast-iron water mains from 4 in. to 16 in. in size in the town of Norton, Mass., and decided to use Leadite for the whole system.

In the case of the Barnstable Water Works the material laid through was largely dry sand; that in the second plant was hard and stony ground, to a great extent in water. I only need to comment on this to say that this plant has now been in operation with pressures varying from 60 to 150 lb. for about four years, and is giving extremely satisfactory results.

Following this, three years ago, the Hanscom Company used Leadite in the complete system for Greenville, Me.; and two years ago in Mattapoisett, Mass. Last year it was used exclusively in Groveland, Mass., and Haverhill, N. H. The total of these plants is approximately seventy miles, with the usual range in size of mains for plants of this kind. The results in every instance have been eminently satisfactory to the contractors and to the owners of the plants.

The Reading Contracting Company have had an experience with Leadite practically identical with that of the Hanscom Construction Company, having used Leadite for a period extending over ten years, and covering thirty miles of pipe lines. No sign of deterioration has appeared in any of their work, and extreme tightness has been obtained in practically all cases.

The principal advantages of Leadite are, in cost of joint material, reduced cost of bell holes, no calking, quick removal, extreme tightness; to say nothing of saving in handling a lighter material.

The disadvantages that we have met with are, the exactness required in melting and pouring joints, only experienced and trained men being suitable for this work.

We have found one test under which Leadite is very apt to fail, where lead joints will hold. That is where pipe is laid around sharp curves, so that one side of the joint is very thin. We have

had a few leaks in the joints of the systems referred to, and in practically every case it has proven to be from the latter cause.

I wish to refer again to the Groveland, Mass., pipe lines, where a particularly good opportunity occurred to get at the condition of the joints. Water for the town of Groveland is furnished by the city of Haverhill and is measured by passing through a Hersey detector meter. The action of the meter aroused suspicion, and the commissioners decided before accepting the plant to have an investigation by an engineer who had had no connection with the works. Mr. W. S. Johnson was chosen to make this test, and as Mr. Johnson has kindly consented to give the results of his investigation in person, the writer will not go into the details further.

It is desirable that some method of testing samples of Leadite be found, but as the composition is known only to the maker, it is rather a difficult matter to arrange. The writer extended a cordial invitation to Mr. McKay to furnish the Association with all details of the composition of Leadite, but Mr. McKay sends regrets.

The conclusions to be drawn from the foregoing experiences seem to the writer positive and to the effect that a very high standard of results can be obtained from Leadite under practically all conditions; that the greater degree of tightness is a very important matter, and worth much effort and expense to obtain; that the saving in cost of joint material and in labor of joint making gives still further cause for its extensive use; and last, that the real key to obtaining these benefits is thorough knowledge of proper methods of handling Leadite and the employment of skilled men.

[Discussion on this subject will be found on page 570.]

LEADITE FOR JOINTS IN CAST-IRON WATER PIPE.

BY W. C. HAWLEY.

[*Read September 7, 1915.*]

This paper was prepared at the request of the chairman of the Convention subcommittee on papers. If I am placed in the somewhat embarrassing position of boosting a proprietary article, my only excuse is the hope that the results of my experience as given in the paper may be helpful to some of the other members of the water-works fraternity.

It is about nine years since Leadite was called to my attention. The first experimental joints which we made with it did not prove satisfactory. Other trials gave better results. A service test was then made on a line of about seventy lengths of 6-in. pipe under light pressure. There was some seepage, but in an hour or two most of the joints had taken up, and in twenty-four hours all but three were tight, and those were easily repaired. Gradually we extended the use of Leadite under higher pressures and to larger pipe, and in two or three years practically abandoned the use of lead. The result of our experience has been most satisfactory. We have laid with it pipe ranging in size from 4 in. to 30 in. in diameter, and under pressures up to 210 lb. to the square inch.

While I know that Leadite is being used by many water-works men successfully, I also know that, after experimenting, a considerable number have given it up, and are still using lead. I have discussed this matter with a number of these gentlemen, and my opinion is, that the failure to get satisfactory results has come from improper manipulation of the material, generally due to a lack of understanding of how it should be used, but in a number of cases, I am sorry to say, due to the calkers or other workmen who feared that if Leadite were adopted they would lose their jobs.

Leadite comes in the form of a fine black powder. About one half of it is sulphur; the other half is, apparently, a finely

ground quartz with probably some lamp black to give it its color. Where melted and cast it becomes a black, hard, dense, vitreous mass. Any one who is familiar with the two substances, lead and sulphur, will realize at once that they have very different characteristics. Lead has a specific gravity of about 11.4; sulphur's specific gracity is about 2.0. In other words, a cubic foot of lead weighs in round numbers 710 lb., while a cubic foot of sulphur weighs 125 lb. Lead melts at about 612 degrees F.; sulphur at about 240 degrees F. Lead is ductile and soft; sulphur is brittle and hard. Lead will flow under a continued pressure of about 500 lb. per square inch; sulphur has a compressive strength of several thousand pounds per square inch. Lead expands one part in 63 012 for each increase of temperature of 1 degree F.; sulphur expands one part in 28 066; and cast iron expands one part in 162 000. It will thus be seen that lead expands about two and one-half times as much as cast iron, and sulphur nearly six times as much as cast iron. Incidentally, that is the reason why a lead joint should never be calked until the lead and iron have cooled to the original temperature of the pipe. Otherwise in cooling there is a shrinkage, and the lead shrinks more than the cast iron, and there will be more or less leakage. In making Leadite, this tendency of sulphur to excessive expansion and contraction as compared with cast iron has to be overcome by the material which is mixed with it. This has been accomplished successfully. Leadite has a strength in compression of about 7 000 lb. per square inch and weighs about 138 lb. per cubic foot.

In using Leadite, it is melted in a pot in the same manner that lead is melted, but since it melts at a much lower temperature, it is melted more easily. A small fire is required, but the Leadite should be stirred frequently from the minute it begins to melt until it is put into the ladle ready to pour the joint. Failure to do this has been the cause of many of the unsatisfactory results obtained. As the Leadite melts it froths and foams, and then, unless removed from the fire, it suddenly becomes thick and pasty. This indicates that the temperature has been raised to too high a point and is the signal to remove the kettle from the fire. Keep stirring. As the temperature then reduces, the

Leadite becomes like a thin, black oil with a peculiar gloss, free from froth and foam, and it is then ready to be poured into the joint. It does not require a man with any great amount of experience or technical ability to melt Leadite. After he has melted it a few times he can perhaps do it without heating it to the point where it becomes thick and pasty, but the safe rule is to carry it to that point.

The joint is yarned in the usual way, except that the yarn does not need to be driven quite so hard as it does for a lead joint which is to be calked. Any ordinary jointer will do, either a clay roll or a rubber band, but, on account of Leadite being so much lighter in weight than lead, in order to fill the top of the joint, the gate must be 8 in. to 10 in. high. This is made by forming a hollow clay cylinder with an internal diameter of about 1 in., and the Leadite is poured into the joint with moderate rapidity until the gate is full to the top. Pouring should be continued as the molten mass in the center of the gate shrinks and settles. The clay roll or jointer may be removed as soon as the joint is hard, but it is well to leave the gate until the joint has thoroughly cooled. When the gate is broken off, care should be taken that none of the Leadite in the top of the joint is cracked or broken. The gate can be thrown into the kettle and remelted.

When Leadite joints have been properly made, a large per cent. of them when tested should be found to be practically tight. There may be a small amount of seepage, and in a very few cases even an appreciable leakage indicated by water dropping from the joint or by a small spray. Practically all of these will take up tight within twenty-four hours, and such as do not become tight are readily made so by cutting out the portion which is leaking and re-running with Leadite, or, in case there is too much water, the portion of the joint which has been cut out can be filled with lead wool. If more than one or two per cent. of the joints made show leakage after twenty-four hours, it is an indication that the joints were not properly made. In a line of 12, 10, and 8 in. pipe, five miles long, laid under my supervision several years ago and tested in the open trench, there was but one leaking joint. This was repaired by cutting out part of the joint and re-running.

Lead has but one advantage over Leadite, namely, that, after

having been run, the joint can be calked. The calking adds materially to the expense of the joint, but there will be occasionally in a city street a joint immediately under some pipe, or otherwise inexcessible, where it may be advisable to use lead, so that in case of the joint being disturbed and leaking in the future it can be readily repaired by calking, whereas if it was Leadite it might be necessary to run a new joint or to cut out part of it, and replace with lead wool.

In practically all other respects Leadite has the advantage over lead. Leadite costs about 10 cents per pound, lead about 5 cents, but Leadite weighs about one fifth as much as lead and hence its cost per unit of volume is about two fifths that of lead. Leadite requires no calking, and this, as will be shown later, is a material saving, not only in the cost of the labor of calking, but in the digging of large bell holes, in addition to which is the saving in cost of inspection in order to insure well-calked joints. There is the further saving in the maintanenace of the ditch and bell hole during the time that the joint is being calked and inspected. This is an important item in bad ground, or in wet trenches.

In a case where there is limited room for calking, Leadite has marked advantage over lead. Some years ago I had a 30-in. pipe burst, the bell of which was very close to a concrete wall. It was barely possible to yarn the joint and then run the joint with Leadite. Had we been compelled to use lead it would have required hours of time to have cut out sufficient concrete to have permitted the calking of the joint. It was imperative that the pipe be repaired quickly, as a large community depended upon the line for its supply, and the use of Leadite saved us from a water famine.

I have found in laying pipe in city streets where we are not able to lay a long line and then test, but have to test maybe every two or three pipe lengths, we can put in a plug and run it with Leadite and test, then cut out the plug in a few minutes and back fill. I think it is even quicker than using testing plugs.

Leadite has another advantage over lead in the fact that it is so much lighter and hence more easily carried to the joint, especially in a deep ditch; also that a sufficient amount can be carried

in one ladle so that a large joint can be made at one pouring, whereas with lead two or three ladles must be used. When lead is at a temperature suitable for pouring, it oxidizes rapidly, and in spite of the utmost care the oxide and dross which gathers on the surface will sometimes be poured into the joint. There is no trouble of this kind with Leadite.

Since lead has practically no elasticity, any movement of pipe laid with lead joints or any continued shock or vibration to the pipe tends to loosen the lead in the joints or in many cases to squeeze it out altogether. Leadite, being elastic, is not so affected. I have known cases of side-hill slips moving a line of pipe laid with lead, and generally the first indication of trouble is a flood caused by the blowing out of a part or the whole of a joint. With Leadite joints, however, while the Leadite may be more or less crushed and may leak slightly, the joints do not blow out. This is a very important advantage, as side-hill slips generally cause damage to adjoining property, and one finds it difficult to convince those who have suffered damage or the Court that the slip caused the leak and not the leak the slip. The extent of the slip is likely to be much greater if there is material leakage from the joints after the pipe has been moved, and the liability for damage is thereby increased.

As stated above, a Leadite joint resists repeated shock. In one case a 20-in. cast-iron pipe, laid with lead, passed under a main line of a railroad on which the traffic was very heavy. For years it has been necessary to periodically uncover that pipe and recalk the joints. About ten years ago the lead in these joints was replaced with Leadite, and I am advised that there has not been a leak in these joints since.

Considering the brittle nature of Leadite, it is surprising what a Leadite joint will stand in the way of movement without serious damage. This has been illustrated in my own experience several times by side-hill slips, and in one case where it was necessary to lower a line of 8-in. pipe for a distance of nearly 300 ft., and to a maximum depth of about 2 ft. The pipe had been laid with Leadite, and it was not supposed that it could be lowered without damage to most of the joints, which would probably require them to be remade. It was decided, however, to try the experi-

ment, and the pipe was lowered, and to our surprise the joints remained tight.

Since Leadite melts at such a low temperature, there is no danger of an explosion, should it be necessary to run a wet joint. Where water is encountered a joint, can be made by leaving an opening at the bottom of the joint, out of which the water can run. An experienced man will then run the joint quickly, and in most cases will make a good job. If, however, the joint still leaks, it is an easy matter to cut the Leadite out where necessary and calk with lead wool. We find lead wool a very useful article in connection with Leadite joints where there is an excessive amount of water. Sometimes a kettle of melted Leadite will catch fire, and, of course, the fumes of the burning sulphur are extremely disagreeable. Usually the fire can be smothered by throwing on quickly some of the cold powdered Leadite. If this does not succeed, however, a pail of water will accomplish the desired end. Those who have seen water poured on to melted lead will be inclined to doubt this statement, but when we consider the low temperature at which the Leadite melts it is evident that there is no danger of an explosion.

Among Leadite's good qualities is the fact that it offers a high resistance to the flow of electricity, thereby reducing materially the danger of damage by electrolysis. A few years ago the United States Bureau of Standards made a test near Pittsburgh of two lines of pipe about a half a mile long, laid parallel in the same street. Both of these lines were crossed by a single-track trolley line and conveyed electricity from the trolley line back to a network of trolley lines in the city. One was a 16-in. cast-iron gas pipe laid with lead joints, the other was a 12-in. cast-iron water line laid with Leadite joints. I do not have the exact figures at hand, but the amount of current passing through the 12-in. water pipe was only a very small fraction of that which was passing through the 16-in. gas pipe.

Last, but not least, of Leadite's good qualities is the saving by its use compared with lead. Roughly speaking, on the ordinary sizes of pipe and under average conditions, this amounts to at least one half of the cost of lead joints. In my own experience, since Leadite was a new material and our pressures unusually

high, I have made Leadite joints with a depth of from $2\frac{1}{8}$ to $2\frac{1}{2}$-in., whereas with lead the joints would be made from $1\frac{3}{4}$ to 2 in. in depth. Used in this way we find, on the average, that the amount of Leadite and lead required for joints of different sizes is as shown in the following table.

TABLE.

Showing the Average Quantities of Leadite and Lead Required for Joints of the Various Sizes of Cast-Iron Pipe.

Diameter of Pipe. Inches.	Leadite. Pounds.	Lead. Pounds.
4	2	7
6	3	10
8	4	13
10	5	17
12	6	21
14	7	25
16	8	29
20	10	37
24	12	45
30	15	57
36	18	69

The amount of Leadite required for a joint is equal to the internal radius of the pipe. I discovered a rather interesting thing in making up the table of weights for lead joints. We have been accustomed to figuring the amount of lead in a joint as three times the radius plus something, and the larger the pipe the more the *something* we add. I found when I had made the above table that for 4-in. pipe I had 7 lb. — twice the diameter less one pound; for 6-in. pipe, 10 lb., or twice the diameter less two pounds; and for all other sizes twice the diameter less three pounds.

On this basis, assuming the cost of Leadite at 10 cents per pound, and lead at 5 cents, lead costs from $1\frac{3}{4}$ to nearly twice as much as Leadite.

Labor costs vary according to the length of pipe laid and the difficulties encountered, but we have found on the average the cost of labor in making Leadite joints, including the melting of the material, the preparation and placing of the roll, yarning and pouring the joint, is one half of the corresponding cost of making lead joints, including the calking, this without making any allow-

ance for the extra cost of inspecting lead joints or for digging bell holes large enough for calking or maintaining bell holes while calking. As an example of what can be done, under good conditions, we have had three men yarn, melt, and pour 95 joints of 8-in. pipe in one day at a total cost for labor of $6.60, or a cost of 7 cents per joint. The total cost, including Leadite, was $49.00, or an average cost per foot of pipe of 4.3 cents. In this case the saving is well over 50 per cent. of the cost of making the same joints with lead.

The use of Leadite has passed the experimental stage. The excellent results obtained with it, the ease with which it is used, and especially its economy, have been demonstrated. The only question remaining is that of its durability. There seems, however, to be no reason to suppose that it will be less durable than lead. In fact, in these days of stray electric currents, it is likely to prove more durable. It would seem to be a material especially well suited for the small water works where it is difficult to secure the services of a calker. Any intelligent laborer can use it with a little instruction and experience. On most work the elimination of the calker — that bane of existence to the superintendent and engineer — would be worth while if it was the only advantage to be obtained. However, with all its other advantages it would seem, in these days of efficiency and economy, that it is at least worth a careful trial.

DISCUSSION.

Mr. J. M. Diven.* Mr. Hawley has given us some information which is entirely contrary to the generally accepted idea concerning Leadite, that is, as to its elasticity. We have generally thought that Leadite was brittle and rigid. The author has, by that statement, headed off some questions the speaker was going to ask; but the greatly differing experiences we hear leave us all in doubt as to whether to adopt Leadite or not. We hear one man tell of satisfactory results; another totally condemns it, both giving personal experiences to back their judgment. One drawback seems to be the proper temperature for melting, and

* Superintendent Water Works, Troy, N. Y.

it would help the novice if the makers of Leadite would devise a melting pot with thermostat or some other device that would give us the proper temperature for melting.

The speaker is still in doubt about the wet joints. Mr. Hawley explained that the jointer is left open at the bottom for the water to run out. It seems as though the Leadite would follow the water; we would like to have a little more explanation of that point from Mr. Hawley. He has also explained the electrolysis feature, which is certainly very interesting.

Another thing which is troubling the speaker a little is why these joints tighten up after two or three weeks, or perhaps some months. It would almost seem as if the joints would be as tight in twenty-four hours as they would be after several weeks.

One other point is the possible injurious action of sulphur on iron. We know that sulphur acts injuriously on iron pipes. The speaker has had to lay water pipes in soil that is impregnated with sulphur from phosphate works, and they did not last long. Is there any possibility of the sulphur in Leadite joints having eventually an injurious action on the pipes?

Mr. Frank L. Fuller.* Mr. President, I suppose that it has always been considered that a lead joint was as flexible a joint as we could have. Mr. Hawley seems to speak of the Leadite joint as being more flexible than a lead joint. I would like to ask him if he means that.

Mr. D. A. McCrudden.† I think that the example Mr. Hawley gave, of dropping an 8-in. pipe two feet in a distance of 300, does not show such an awful lot of flexibility. If he had tried to drop a 38- or 48-in. pipe three feet in about 300 it would have made a lot of difference. I do not think he could get the Leadite back.

Mr. George H. Finneran.‡ I should like to ask Mr. Hawley if he has found that Leadite is subject to deterioration with age and exposure to the weather and to water. Also, if, when Leadite reaches that thick stage that he speaks of, wherein it is supposed

* Civil Engineer, Boston, Mass.

† Purveyor, Bureau of Water, Philadelphia, Pa.

‡ Assistant Superintendent, Water Service, Boston, Mass.

to be too hot, he removes the heat entirely or allows just a little heat to play upon the pot?

Mr. Hawley. Answering the last question, we simply take the fire away from the kettle or the kettle away from the fire and keep stirring it. After a while it thins down to the proper consistency for pouring. As to its deterioration with age, we have found no indication yet of any deterioration.

Mr. Finneran. About six years ago we tried Leadite in Boston and laid about 300 ft. of 8-in. pipe with success. It is in the ground to-day and there is no indication of leakage. We then endeavored to find out how large a joint could be made up with Leadite. We tried several times unsuccessfully to join 30-in. and 20-in. caps to the ends of a 30 by 20 reducer. Each time the joints failed to hold the ordinary low-service pressure of 50 lbs. We finally gave it up. We still have on hand some of the Leadite used at that time and recently have used it with good results. I am wondering whether it would retain its effectiveness indefinitely. Some such compositions deteriorate with age and change of conditions. Have you had any experience in that line?

Mr. Hawley. No, sir. So far as I know the element sulphur, I think that we have no reason to expect it to change merely from age. Mr. Diven's experience with cinders, of course, is an entirely different proposition. When the coal burned, the sulphur which it contained was oxidized to sulphur dioxide, some of which remained in the cinders. This was leached out by water and formed sulphuric acid. Pure sulphur does not attack the iron in the pipes, though it seems to take hold of the inside of the bell much better than lead. Most of us have used sulphur for setting holding bolts or engine beds without expecting it to attack the iron in such cases.

As to the difficulties of melting, I expected some trouble from our men who had been using lead, so we chose a boy about eighteen or nineteen years old, — a water boy, — and after our foreman had experimented enough with Leadite to learn how to use it, he taught that boy how to use it. He is the one who has melted the Leadite and run the joints for several years, and we have another boy that is doing it. We have found no difficulty with it so long

as they do it carefully, bring it up to the temperature where it begins to thicken and then let it cool down. In regard to the large-sized joints Mr. Finneran speaks about, we have had no difficulty except in the case of some valves or sleeves where the joint was large, that is, thick. When we get up to an inch or an inch and an eighth joint we have some trouble. Yet we have run some of those large joints.

Mr. Diven. It would be interesting if one of the writers would explain whether the Leadite joints are melted or cut out with a chisel, and about the disposal of water in the joints when pipes are laid in wet trenches.

Mr. Hawley. As far as my experience goes in cutting out joints, it is the practice to dovetail back both ways with a chisel. Leadite cuts out a good deal like hard putty around a window pane. Of course, while Leadite itself is hard, it is elastic. Glass is hard, steel is hard, but they are elastic. You can bend a pane of glass or a bar of steel and they will spring back to their original position. Lead, on the other hand, is not elastic. Bend a piece of lead pipe and it does not spring back to its original shape; strike it with a hammer, and it makes a dent; the hammer does not rebound. Referring to the running of wet joints, I have had no personal experience, but in talking with my foreman the other day he told me that when he has trouble with water he leaves a small opening at the bottom of the joint and then pours the joint quickly. Generally the joint is tight; if not, that portion which leaks is cut out, being dovetailed back on each side, and it is calked with lead wool.

Mr. George F. Merrill. I would like to know how a Leadite joint compares in conducting electricity with a lead joint — how it affects it.

Mr. Hawley. Sulphur has a very high resistance to the flow of electricity. We tested out Leadite by trying to pass a current of electricity through it. It practically stopped the electric lighting current. We have, in a number of cases where we have had a break, replaced the pipe with a sleeve, using Leadite. The Bureau of Standards, when their men were there, tested some of

* Superintendent Water Works, Greenfield, Mass.

those and found the resistance to the flow of electricity very much higher than where lead was used.

Mr. Diven. Would not the high resistance be an objection, because when the electric current reached the joint it would jump to the next length of pipe, and the point of leaving the pipe is where the injury is done.

Mr. Hawley. It is true that when the electric current reaches the joint it will have to jump to the next length of pipe, but the high resistance of the Leadite joints increases the total resistance of the line to such an extent that the amount of electricity returning to the generator is very much less than where lead is used. Since the damage by electrolysis is in direct proportion to the amount of current, and since Leadite by increasing the resistance materially reduces the amount of current, it reduces the damage by electrolysis.

In the city of Pittsburg they have undertaken to overcome their electrolysis troubles not by increasing the resistance, but by putting bonds around the joints. They have thus decreased the resistance tremendously. The result is that they are returning an astonishing amount of electricity by way of their pipe lines, and the trouble is that their electrolysis troubles later are going to be general instead of local. In these lines I spoke of, the 12-in. water line and 16-in. gas line, if I remember rightly, the amount of electricity through the water line was one one-hundred and fiftieth of that flowing through the gas line. Now that amount is going to do much less damage than the large amount of current going through the gas pipe.

Mr. A. E. Martin.* In Springfield, Mass., we have had a little experience with Leadite during the last year. We have laid perhaps half a dozen miles of 8-in. pipe this year with Leadite joints and have had very good results. But one or two experiences on a little larger scale may be worth while to present at this time. Of course, in commencing its use we asked the Leadite men for help, and one of their representatives came to us to show us how to melt it. We had to make an 8-in. connection with a 30-in. line, using the tapping machine and split sleeve, and asked

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* Superintendent Water Works, Springfield, Mass.

him if he would advise the use of Leadite in making the joint. He assented and poured the joint with Leadite, and when the water first came while tapping the pipe it leaked very fast. We were afraid of it, but he said, " Keep on." We made the cut and when we got it made the leak virtually stopped. We left it open twenty-four hours after making the connection with the line and it was perfectly tight at the end of that time. But a peculiar thing about the job was that we had not used Leadite in laying the 8-in. pipe connection to it, and in driving the lead joints of the connection near this tap, we loosened the sleeve joint and got lots of water again. He still said, " Let it rest and I will guarantee it will be tight in twenty-four hours," — and it was. The joint still " rests," and we have had no trouble with it. We have tapped the 30-in. pipe a number of times during the last year, using Leadite for the joints, and have had no trouble.

We have made one 8-in. tap off a 36-in. pipe for a hydrant connection, where we have a working pressure of 150 lb. The joint acted in much the same way and we were rather timid about it. The representative was not with us at that time. But within twenty-four hours the leaks had entirely ceased and everything has been all right so far. It was perhaps four months ago when we made this last test.

Another experience we had may be of interest. We have still some cement-lined iron water mains in Springfield, and among others a 24-in. supply line from the old Ludlow reservoir. We have had to tap that main in several places, and in the first tap we made, we had bad luck with the Leadite; we left the joint for twenty-four hours, but there was apparently no difference in the leak. The foreman did not want to take off the sleeve and run the joint again and I did not want to cut the pipe and put in a T, so I allowed him to experiment with it. He shut the water off, draining it below the outer joint, and then cut the Leadite out completely through the sleeve, right in the neck of the valve. Then he ran that part of the joint over again, and it came out perfectly tight — and we have no further trouble with it.

Mr. Lincoln Van Gilder * (*by letter*). Our twelve years,

* Engineer and Superintendent Water Department, Atlantic City, N. J.

experience with Leadite for pipe jointing, as noted in Mr. Symonds's paper, has been very satisfactory, and a recent experience has developed a new feature that may be of professional interest.

The new Hotel Traymore is equipped with high lift plunger elevators, the casings for which were driven for the most part through saturated sand with the casing heads and valve gear considerably below ground water level.

In finishing the pits the contractors were unable to stop the seepage, especially around the casings.

About half the required thickness of pit bottom was laid with concrete, and after hardening a thin layer of molten Leadite was poured all over it, the ground water being kept down by pumping until the Leadite was chilled. The pit was then filled to the required elevation with concrete.

Ten elevator pits were treated in the same way and every one is water tight.

In the same hotel it was necessary to tun two 4-in. discharge pipes through the side of a large concrete tank built for sea-water storage.

Rough holes were cut, the pipes run through and the space between pipes and concrete poured full of molten Leadite. These joints are dry.

All of the Leadite used on this work was handled by water department men, as the contractors had no knowledge of its properties or methods of application except by observation of the department's work on the adjacent street.

PROCEEDINGS.

HOTEL BRUNSWICK,
BOSTON, MASS., November 10, 1915.

Vice-President William F. Sullivan in the chair.
The following members and guests were present:

HONORARY MEMBERS.

E. C. Brooks, R. C. P. Coggeshall, Albert S. Glover, F. E. Hall, W. T. Sedgwick, and G. A. Stacy. — 6.

MEMBERS.

L. M. Bancroft, J. W. Blackmer, F. L. Cole, J. H. Cook, A. W. Dudley, E. D. Eldredge, G. F. Evans, S. F. Ferguson, F. L. Fuller, Patrick Gear, F. J. Gifford, H. J. Goodale, R. K. Hale, E. A. W. Hammatt, L. M. Hastings, D. A. Heffernan, A. C. Howes, Willard Kent, G. A. King, John Knickerbacker, H. V. Macksey, A. E. Martin, W. E. Maybury, John Mayo, H. A. Miller, William Naylor, F. L. Northrop, T. A. Pierce, W. H. Pitman, J. L. Rice, L. C. Robinson, H. F. Salmonde, G. A. Sampson, P. R. Sanders, C. M. Saville, A. L. Sawyer, J. E. Sheldon, C. W. Sherman, E. C. Sherman, H. H. Sinclair, J. T. Stevens, W. F. Sullivan, R. J. Thomas, J. A. Tilden, A. H. Tillson, D. N. Tower, W. J. Turnbull, W. H. Vaughn, R. S. Weston, F. B. Wilkins, F. I. Winslow, G. E. Winslow, L. C. Wright. — 53.

ASSOCIATES.

Harold L. Bond & Co., F. M. Bates; Builders Iron Foundry, A. B. Coulters, F. N. Connet, and D. K. Bartlett; A. M. Byers Co., H. F. Fiske; Central Foundry Co., W. H. Felet; Chapman Valve Mfg. Co., J. T. Mulgrew; Darling Pump and Mfg. Co., Ltd., H. A. Snyder; *Engineering Record*, I. S. Holbrook; Hayes Machinery Co., F. H. Hayes; Hersey Mfg. Co., James A. Tilden, Albert S. Glover, and J. Herman Smith; Ludlow Valve Mfg. Co., A. R. Taylor and G. A. Miller; H. Mueller Mfg. Co., G. A. Caldwell; National Meter Co., J. G. Lufkin and H. L. Weston; Neptune Meter Co., H. H. Kinsey; Pittsburgh Meter Co., J. W. Turner; Rensselaer Valve Co., F. S. Bates and C. L. Brown; A. P. Smith Mfg. Co., F. L. Northrop; Thomson Meter Co., E. M. Shedd; Union Water Meter Co., F. E. Hall and D. K. Otis; Water Works Equipment Co., W. H. Van Winkle; Henry R. Worthington, Samuel Harrison, and W. F. Bird. — 29.

GUESTS.

Hazen Pillsbury and Wm. F. Hunt, Lowell, Mass.; F. O. Eichelberger, Dayton, Ohio; Louis W. Thayer, Braintree, Mass.; J. A. Tilden, Jr., Boston, Mass.; E. J. Dunphy, Cambridge, Mass. — 6.

VICE-PRESIDENT SULLIVAN. It is with regret that I announce the death this week of a long-time member of this Association, a man who for over twenty-five years has attended these meetings. I refer to Mr. Eben R. Dyer, of Portland, Me., superintendent there so many years. I understand his funeral takes place about this hour to-day, and as a mark of respect I would ask all the members to rise and remain standing in silence.

The members stand in silence, as requested.

MR. R. C. P. COGGESHALL, of New Bedford. Mr. President, It is with a sudden shock that I heard this sad tidings. It seems as though death had been very busy in our ranks of late. Fully twenty-five years I have known Eben Dyer and known him to be a good citizen, a conscientious official, and a worthy member of this Association. Peace be to his memory.

The Secretary presented the following applications for membership, properly endorsed and recommended by the Executive Committee:

Active: Homer R Turner, Windsor, Conn., superintendent Water Department of the Windsor Fire District; Hazen G. Pillsbury, Lowell, Mass., service clerk, Lowell Water Department; Homer F. Cox, Scranton, Pa., railroad and general engineering work; Horace Belden, Simsbury, Conn., president and manager Simsbury Water Co.; Thomas Grieve, Perth Amboy, N. J.; M. Z. Bair, Columbus, Ohio, assistant engineer Ohio State Board of Health; J. Arthur Durst, Philadelphia, Pa., water-works construction; Frank E. Hale, Brooklyn, N. Y., director of laboratories, Department Water Supply, Gas and Electricity, New York City; Charles H. Fischer, Jersey City, N. J., examining water-works systems from a fire protection standpoint; Ernest B. Bain, superintendent water works, Raleigh, N. C.; C. L. Kirk, Indianapolis, Ind., president Indianapolis Water Co.; John Gaut, Washington, D. C., water filtration; Dow R. Gwinn, Terre Haute, Ind., president and manager water works; F. O. Eichelberger, city engineer, Dayton, Ohio. — 14.

Associate: Lock Joint Pipe Co., New York City, manufacturers of reinforced concrete pipe. — 1.

On motion, duly seconded, the Secretary was directed to cast the ballot of the Association in favor of the applicants, and he having done so they were declared duly elected members of the Association.

Mr. Charles W. Sherman. Mr. President, Mr. Frederic P. Stearns was unfortunately called out of Boston last evening, and asked me to present in his behalf the report of the Committee on the Dexter Brackett Memorial, together with a memoir on Dexter Brackett's life.

The report and memoir were read by Mr. Sherman, and on his motion it was voted that they be accepted and printed in the Journal and a copy sent to Mrs. Brackett, the adoption of the motion being expressed by a rising vote.

Mr. Sherman. Mr. President, the committee was charged with two duties: first, to prepare the memorial which I have just read; and, second, to consider a proposition offered at the convention in New York last September as to a memorial in the Association to Mr. Brackett's memory. The report on the second subject is as follows:

November 9, 1915.

To the New England Water Works Association:

Gentlemen, — The committee appointed by your President, under a resolution adopted at the last annual convention of the Association, to consider the question of a suitable form of memorial to perpetuate the memory of Past President Dexter Brackett, has given the matter careful consideration.

The committee believes that there should be a memorial and that the most appropriate form is a bronze medal, to be awarded each year as a prize for a meritorious paper. It seems desirable, if the Association adopts the views of the committee, that much care should be taken in formulating the rules for the award of the medal, and that a committee be appointed for this purpose.

The committee is of the opinion that an artistic bronze medal is preferable to one made of gold, and quotes the reasons given in another case by our fellow-member, Mr. Desmond FitzGerald, that "the prize should be valued not for its intrinsic worth but solely as a testimonial that the holder of it has contributed something which his fellow-members consider of great value . . . ; also that the evidence of having received such an award will be more available and less likely to be deposited where it can seldom be seen if the medal is of bronze rather than of a precious metal."

Inquiry of Mr. FitzGerald, who has had experience in these matters, elicited the information that a satisfactory result could not be secured much short of

$1,000. The expenditure would be required mainly for the artistic design and the cutting of the dies, as the cost of the medals themselves would be small.

The committee thought it undesirable to make a general request for subscriptions from members of the Association, and has therefore sent a request to about forty persons, nearly all members of the Association intimately acquainted with Mr. Brackett, asking them to subscribe to a guarantee fund. Although the request was made only a few days ago and the returns have not all been received, the response has been a very generous one, and it is evident that a sufficient sum will be guaranteed.

Although the committee has ascertained that a comparatively few members of the Association are willing to guarantee the success of the fund, it believes that other friends of Mr. Brackett who are members of the Association should be given an opportunity to make a small subscription if they so desire, and the committee therefore recommends that if its views are adopted a notice be sent to all members, not as an appeal or even a request for subscriptions, but rather to give an opportunity for those who desire to subscribe to the fund.

My associates on the committee, Messrs. Alfred D. Flinn and Allen Hazen, have expressed views which accord with the statements in this report, but to avoid delay it has not been submitted to them in its final form.

For the committee,

Frederic P. Stearns.

Mr. Sherman. I will say, Mr. President, that in order to be sure that this subject received more adequate consideration than was usually possible at a general meeting of the Association, the Executive Committee at its session this morning took it under consideration and has prepared the following vote for submission to the meeting, of which it recommends the adoption.

Voted, That the report of the Committee on the Brackett Memorial be adopted and they be requested to formulate a notice to be sent to the membership so as to give an opportunity for all to subscribe, and that the President appoint a committee to receive subscriptions, procure a medal of suitable design, and to formulate rules for the annual award of such medal.

On motion duly made and seconded it was voted that the report be accepted and its recommendations adopted.

It was further voted that the motion submitted to the meeting by the Executive Committee be adopted.

Vice-President Sullivan. The next business is the report of the Committee on Engineering Coöperation.

Secretary Kent. Mr. Davis of the committee writes as follows.

[The letter from Mr. Carleton E. Davis is read by the Secretary, and on motion duly made it is voted that the report be accepted and the recommendation adopted.]

Secretary Kent. I have here a communication from the Committee of Manufacturers on Standardization of Fittings of Valves.

The communication from the Committee of Manufacturers on Standardization of Fittings of Valves, by A. M. Howser, was read by the Secretary.

Mr. Brooks. I move that a committee be appointed on valves, to confer with the committees from the other societies, to arrive at a uniform standard, if possible, for water-works and other works.

Vice-President Sullivan. Of how many, Mr. Brooks?

Mr. Brooks. I will leave that with the Chair.

The motion, being duly seconded, is adopted.

Mr. Coggeshall. Mr. President, I have a little matter that I want to bring before this Association. A few days ago a committee of the Master Plumbers Association in New Bedford appeared before the New Bedford Water Board, not in a complaining mood, but in an attitude asking advice. It seems that we have had two very disastrous domestic hot water boiler explosions in New Bedford. While they recognize that the function of the Water Department was simply to deliver the water into the house and that it was not responsible after that, they did want to know if the Water Board could give them any advice as to procedure in the matter of installation to prevent the occurrence of such troubles. We all know the troubles that have come by the vacuum that is created by the shutting off of mains. But this is a real boiler explosion. We none of us think it is possible for that thing to happen as long as there is a direct connection maintained between the boiler and the city main, because we believe the pressure would adjust itself. Nevertheless, this has occurred, and they have asked for advice on that point. Some of them have already been installing safety valves. Of course, some of our valve men tell us that they have got perfect safety valves, but

some of us think the perfect safety valve is going to come about the time a man dies and then it will be of no use. I told them I would bring that matter up before the Association, and that perhaps some members could later on help solve that problem. I am going to suggest that that be assigned as a topic for discussion at the next meeting, or whenever the committee sees fit to put it on the program. I make that as a motion.

The motion, being duly seconded, is adopted.

There being no further business to come before the meeting, the first paper of the day was read by Mr. Arthur W. Dudley, consulting engineer, Manchester, N. H., the subject of the paper being "Experience with Wood Water Pipe in New Hampshire." Mr. Dudley's paper was illustrated by lantern slides. It was discussed by the following named gentlemen: Messrs. Richard A. Hale, of Lawrence, Mass.; Mr. F. I. Winslow, of Boston; Mr. Gorham Dana, of Boston; Prof. Dwight Porter, of Boston; Mr. Frank L. Fuller, of Boston.

Mr. Edward C. Sherman, consulting engineer, Boston, Mass., contributed the next paper, on "The Wakefield Water Sterilization Plant," the paper being illustrated by lantern slides. Messrs. Frank L. Fuller and Robert S. Weston, of Boston, and Caleb M. Saville, of Hartford, Conn., discussed the paper, and a written contribution to the discussion from Mr. J. A. Kienle, of New York, was presented.

Prof. William T. Sedgwick, Professor of Biology and Public Health at the Massachusetts Institute of Technology, delivered an address on "Water Supply Sanitation in the Nineteenth Century and in the Twentieth," the address being commented upon by Mr. Robert S. Weston.

Following Professor Sedgwick's address, Vice-President Charles W. Sherman read a paper on "Grouting or Cushioning Standpipe Bases," the paper being discussed by Mr. Frank L. Fuller, of Boston. This completed the program of the meeting.

Mr. Bates.* Mr. President, as an associate member I would like to have the privilege of the floor for a minute. During the first part of the afternoon session a paper in regard

*Of the Rensellaer Valve Co.

to valve manufacture came up, and a communication was read from Mr. Howser saying that it had been referred to the valve manufacturers. Since the reading of the paper the valve manufacturers here have gone over this matter carefully and find that that set of specifications has never been before the valve manufacturers, and we are completely ignorant of it. Such being the case, we would like to have Mr. Brooks reconsider his motion and have the same laid on the table.

Mr. Brooks. I think, Mr. President, that if it is a fact that that communication which was read at the meeting of the Executive Committee was not duly authorized, it would be rather unwise for us to take action on it. I would like an expression of opinion on that.

Vice-President Sullivan. As I understand the motion made by Mr. Brooks, it was that the President should appoint a committee to get up specifications for a standard valve.

Mr. Brooks. Well, it was to confer with —

Vice-President Sullivan. With the other associations.

Mr. Brooks. With the other committee. Now, have we any evidence except this, that a conference is desired?

Vice-President Sullivan. What is your pleasure, gentlemen?

Mr. George A. Stacy, of Marlboro. Mr. President, it seems to me that we were laboring under a misunderstanding. As I understood it, this virtually comes from the valve manufacturers. That is, they had been conferred with and had consented to this being presented to this meeting at that time. If that is erroneous, certainly we ought to drop the subject.

Vice-President Sullivan. Mr. Bates, how many valve manufacturers have been in meeting this afternoon?

Mr. Bates. The Chapman, Ludlow, Rensellaer, and Eddy valve companies were represented.

Vice-President Sullivan. They know nothing about this?

Mr. Bates. No, sir. This communication came from one concern only.

Mr. Brooks. I will make a motion, Mr. President, that the motion to appoint the committee be reconsidered.

The motion being duly seconded is adopted.

MR. BROOKS. I would move now that the matter be laid on the table.

The motion being duly seconded is adopted.

On motion of Mr. Charles W. Sherman, the meeting adjourned.

DECEMBER MEETING.

HOTEL BRUNSWICK,
BOSTON, December 8, 1915.

Vice-President Sullivan in the chair.

The following named members and guests were in attendance:

HONORARY MEMBERS.

E. C. Brooks, R. C. P. Coggeshall, Albert S. Glover, F. E. Hall, G. A. Stacy, and R. J. Thomas. — 6.

MEMBERS.

C. L. Baker, L. M. Bancroft, F. A. Barbour, A. E. Blackmer, J. W. Blackmer, Bertram Brewer, G. A. Carpenter, W. R. Conard, B. I. Cook, C. E. Davis, A. O. Doane, John Doyle, H. P. Eddy, W. R. Edwards, E. D. Eldredge, F. L. Fuller, Patrick Gear, H. T. Gidley, F. J. Gifford, T. C. Gleason, H. J. Goodale, F. W. Gow, F. H. Gunther, R. K. Hale, C. R. Harris, T. G. Hazard, Jr., D. A. Heffernan, J. L. Howard, G. A. Johnson, E. W. Kent, Willard Kent, S. E. Killam, G. A. Kent, John Knickerbacker, Morris Knowles, H. O. Lacount, F. A. McInnes, H. V. Macksey, A. E. Martin, W. E. Maybury, John Mayo, J. H. Mendell, F. E. Merrill, G. F. Merrill, H. A. Miller, F. L. Northrop, H. E. Perry, Dwight Porter, H. G. Pillsbury, J. H. Remick, L. C. Robinson, G. A. Sampson, P. R. Sanders, C. M. Saville, A. L. Sawyer, W. P. Schwabe, J. E. Sheldon, C. W. Sherman, E. C. Sherman, H. H. Sinclair, G. Z. Smith, Sidney Smith, W. F. Sullivan, H. A. Symonds, R. D. Thorpe, E. J. Titcomb, D. N. Tower, W. J. Turnbull, C. H. Tuttle, R. S. Weston, F. B. Wilkins, F. I. Winslow, G. E. Winslow, I. S. Wood. — 74.

ASSOCIATES.

Harold L. Bond & Co., H. L. Bond and G. S. Hedge; Builders Iron Foundry, A. B. Coulters; A. M. Byers Co., H. F. Fiske; Darling Pump and Mfg. Co., Ltd., H. A. Snyder; *Engineering News*, Harry Barker; Hersey Mfg. Co., Albert S. Glover and J. Herman Smith; Lead Lined Iron Pipe Co., T. E. Dwyer; Ludlow Valve Mfg. Co., A. R. Taylor and G. A. Miller; National Meter Co., J. G. Lufkin and H. L. Weston; National Water Main Cleaning Co., B. B. Hodgman; Neptune Meter Co., H. H. Kinsey; Pittsburgh Meter

Co., J. W. Turner; Rensselaer Valve Co., F. S. Bates, C. L. Brown; A. P. Smith Mfg. Co., F. L. Northrop; Standard Cast Iron Pipe & Foundry Co., Wm. F. Woodburn; Thomson Meter Co., E. M. Shedd; Union Water Meter Co., F. E. Hall and E. K. Otis; Water Works Equipment Co., W. H. Van Winkle; R. D. Wood & Co., H. M. Simons; Henry R. Worthington, Samuel Harrison, and W. F. Bird. — 28.

GUESTS.

James J. Scully, president Water Board, Cambridge, Mass.; L. M. McKenney, inspector, Portland, Me.; Frank S. Hamlin, commissioner, Haverhill, Mass.; W. H. Lem, commissioner, Abington, Mass.; W. A. Bradford, Quincy, Mass.; W. P. Melley, inspector, Milton, Mass.; C. A. Bingham, general manager, Norwood, Mass.; R. A. Callum, superintendent, Cherry Valley, Mass.; J. M. Stevenson; George W. Simons, assistant professor Massachusetts Institute of Technology, Boston, Mass.; T. C. Atwood, New Haven, Conn.; H. W. Dotten, Waterford, N. Y.; E. S. Locke, Lexington, Mass.; H. W. Coombs, Boston, Mass., and Col. S. A. Carter, chairman Water Board, Concord, N. H. — 15.

The Secretary presented applications for membership from the following named, properly endorsed and recommended by the Executive Committee:

William E. Whittaker, Somerville, Mass., civil engineer, etc., Metropolitan Water Works; William N. Davenport, Newton, Mass., secretary Metropolitan Water and Sewerage Board; Henry T. Sawyer, Brighton, Mass., inspector and foreman for the Metropolitan Water Works since August, 1897; Charles A. Farnham, Collinsville, Conn., superintendent Collinsville Water Co. since 1904; Thomas C. Atwood, New Haven, Conn., now consulting engineer, previously connected with the Metropolitan Water Works, U. S. Engineers' Office in Boston, Philadelphia and Pittsburgh Filtration Works, and the New York Water Supply; W. Dayton Frederick, Bridgeton, N. J., commissioner of public works; J. Frederick Jackson, New Haven, Conn., general engineering practice, water and sewerage works; F. Spencer Goodwin, Hartford, Conn., water commissioner; John Franklin, Andover, Mass., private engineering practice, formerly city engineer of Hudson, N. Y.

On motion of Mr. Sherman the Secretary was directed to cast a ballot in favor of the applicants named, and, he having done so, they were declared duly elected members of the Association.

Vice-President Sullivan then called for any other business.

Mr. Henry A. Symonds. There is one matter, Mr. President, which I want to mention to-day, for the conditions are such at this meeting that I think something should be done to start the matter off. I refer to the question of having some sort of a representation of this organization before the legislative committees. Before another meeting of the Association the legislature of Massachusetts will have convened, and I think the legislatures in some of the other New England states are coming together at about the same time. It has seemed to me, and to others who have been called in consultation in a personal way in connection with matters that are brought before the legislature of Massachusetts, that this organization should be represented, and should be better informed through some such representation of what is being done and what is being proposed along the lines of matters having to do with the question of water supply. I invited the Senate chairman of the last year's water supply committee to be with us here to-day, and hoped that he might give to the Association a few of the points that he has given to me as to the difficulties which the water supply committees encounter in trying to pass upon matters which are presented for their consideration. The committee is usually composed very largely, if not entirely, of men who have had no connection whatever with water supplies, and the men who come before the committee are very largely men who have private interests. It is very seldom that the general community is represented by any one.

There is no question but that this organization stands in a position more fully representing the best interests of the people of New England than any other body of men, and it seems to me that there is something wrong when laws vitally affecting questions of water supply in New England and in the country at large are being put through the legislature without even one in a hundred, I might say, of the members of this Association having knowledge that such measures are being proposed.

In speaking of this matter to-day, I have not been able to formulate any definite plan, or, at least, anything more definite than to suggest that a committee be appointed to look into this matter. I appreciate the fact that many obstacles will occur to you at once in considering the question of the possibility of supervising

or looking into the proposed measures of this nature throughout the New England states, but it seems to me that there may be a way of getting around the obstacles in a manner which will be a benefit to the Association and to the communities.

During the last session of the legislature, several measures were proposed, and through the mere circumstance that some one interested in water matters generally happened to notice them upon the calendar, and sent out a few letters to friends and others who would be interested and thereby secured a fair representation, it happened that some very unfortunate measures were prevented from becoming laws, — measures which were entirely local, in some cases, but, nevertheless, which would have done considerable harm to the general question of water supply. We have some laws on our statute books at the present time that I am sure never would have been favored by this Association as a whole.

Now, to bring this matter to a head, I will make a motion that a committee of five be appointed by the Chair to look into this matter and to propose at some future meeting some method of taking care of it.

The motion was seconded by Mr. Robert J. Thomas.

Mr. Walter P. Schwabe. I would suggest that one member be appointed from each New England state, so that the number will be six instead of five.

Mr. Charles W. Sherman. I object to the amendment suggested. It seems to me we will do far better if we concentrate on one state in the first place and find out whether it is desirable for the Association to go into the matter at all. Then, if we find it is desirable in Massachusetts, it may be equally desirable in some other states; and if it is found not to be desirable in Massachusetts, it would be better to keep out of it entirely. I suggest that the committee consist of five members from Massachusetts, and that they take up the matter as affecting Massachusetts first, and afterwards, if it is found to be desirable, it can be extended to other states.

Mr. George A. King. Mr. Symond's motion is that the committee should report back to the Association some method for taking action. I would suggest that the committee be in-

structed to consider merely the advisability of the Association taking any action.

VICE-PRESIDENT SULLIVAN. Will the maker of the motion please state it again?

MR. SYMONDS. I would like to withdraw the motion as I made it originally, and I would move that a committee of six be appointed to look into and report back to the Association the advisability of its being represented before the legislatures of New England in connection with matters affecting the question of water supply.

MR. JOSIAH S. MAXCY. As I understand the motion, it seems to me that it is not in quite the shape that it ought to be in order to handle this matter well. It embodies the idea of having some one whose duty it will be to represent the Association before the various legislatures of New England. Now, if we are to have a man who is able to represent the Association properly, and who is willing to give the time that is necessary, it means that we must pay him. There are too many attempts being made of late to utilize ability for nothing, and when you try to do that you generally buy a gold brick. Now, it is all right to have a legislative committee which can keep in touch with the various matters of interest to us which come before the legislature, and when they thought any particular legislation should be opposed they could come back to the Association, or to the directors, and get money and hire a man to do a good job. That would be all right; otherwise, merely saying that we shall be represented may mean that we will not be represented at all, or possibly will be misrepresented.

Mr. Symonds' motion was rejected.

MR. H. P. EDDY. In spite of the apparent disinclination of the Association to pass this motion, I believe there is a general feeling among a great many that this is a matter of considerable importance and one that should receive the consideration of this Association in the proper way and at the proper time. It occurs to me that the wisest way to handle the matter is to refer it to our Executive Committee with power to report back — which it would have without special authority — to the Association what action it thinks the Association should take. Therefore I move you that this matter be referred to the Executive Committee.

Mr. Eddy's motion was adopted.

Caleb Mills Saville, chief engineer Hartford Water Works, then presented a paper, illustrated by stereopticon views, entitled, "Some Water-Works Experiences: Emergency Pumping Station; Testing Distribution Main; Old-Cast Iron Pipes; Double Check Valve Experiences; Losses in Fire Hydrants; Throttling Gates to Conserve Water; Foundry Rejections of Cast-Iron Pipe."

The paper was discussed by Mr. R. C. P. Coggeshall, Mr. Frank A. Barbour, Mr. Frank A. McInnes, Mr. Carleton E. Davis, Mr. William R. Conard, Mr. Kunhardt, and Mr. H. O. Lacount.

Mr. George A. Sampson, civil engineer, Boston, Mass., read a paper entitled, "The Middleboro, Mass., Reinforced Concrete Tower Tank."

Adjourned.

EXECUTIVE COMMITTEE.

Meeting of the Executive Committee of the New England Water Works Association at headquarters, Tremont Temple, Boston, Mass., at 11 o'clock A.M., Wednesday, November 10, 1915.

Present: William F. Sullivan, Charles W. Sherman, Edwin C. Brooks, Richard K. Hale, Lewis M. Bancroft, George A. King, and Willard Kent; Vice-President Sullivan presiding.

Fourteen applications for active membership were received, viz., Horace Belden, president and manager Simsbury Water Company, Simsbury, Conn.; Hazen G. Pillsbury, service clerk, Water Department, Lowell, Mass.; Homer R. Turner, superintendent Water Department, the Windsor Fire District, Windsor, Conn.; F. O. Eichelberger, city engineer, Dayton, Ohio; Dow R. Gwinn, president and manager Terre Haute Water Company, Terre Haute, Ind.; John Gaub, Washington, D. C.; C. L. Kirk, president Indianapolis Water Company, Indianapolis, Ind.; Ernest B. Bain, superintendent water works, Raleigh, N. C.; Chas. H. Fischer, Jersey City, N. J.; Frank E. Hale, director of laboratories, Department Water Supply, Gas, and Electricity, New York City; J. Arthur Durst, Philadelphia, Pa.; M. Z. Bair, assistant engineer, State Board of Health, Columbus, Ohio; Thomas Grieve, Perth Amboy, N. J., and Homer F. Cox, Scranton, Pa.; one for associate, viz., Lock Joint Pipe Company, New York, N. Y., and they were by unanimous vote recommended therefor.

President Metcalf was, by vote, authorized to appoint a representative of the Association to attend the Second Pan-American Scientific Congress at Washington, D. C., December next, and an expenditure not to exceed fifty dollars is to be allowed for his expenses.

The report of the Committee of Arrangements of the last annual convention was received, read, and placed on file.

The report of the Committee on Memoir and Memorial of the late Dexter Brackett, President of the Association 1889–90, was presented, read, and ordered presented to the Association with

the recommendation of the Executive Committee that the suggestions therein be adopted and a committee appointed for their consummation.

A communication from the chairman of the Committee on Dimensions and Specifications of the Committee of Manufacturers on Standardization of Fittings and Valves, with reference to standard specifications, was read, and it was voted that the matter be presented to the Association.

The Committee on Engineering Coöperation, viz., Messrs. Carleton E. Davis, William F. Sullivan, and George W. Batchelder, reported that "the committee has considered the matter carefully and its conclusions are to the effect that the Association should not at this time take definite steps toward joining in the movement for engineering coöperation.

Adjourned.

Attest: WILLARD KENT, *Secretary.*

Meeting of the Executive Committee of the New England Water Works Association at headquarters, Tremont Temple, Boston, Mass., December 8, 1915, at 11 o'clock A.M.

Present, Carleton E. Davis, George F. Merrill, Charles W. Sherman, William F. Sullivan, Edwin C. Brooks, Samuel E. Killam, Lewis M. Bancroft, George A. King, and Willard Kent.

Nine applications for membership were received and they were by unanimous vote recommended therefor.

Charles F. Farnham, superintendent Collinsville Water Company, Collinsville, Conn.; Thomas C. Atwood, consulting engineer, New Haven, Conn.; J. Frederick Jackson, consulting engineer, New Haven, Conn.; F. Spencer Goodwin, water commissioner, Hartford, Conn.; John Franklin, consulting engineer, Andover, Mass.; Henry T. Sawyer, inspector and foreman Metropolitan Water Works, Brighton, Mass.; William N. Davenport, secretary, Metropolitan Water and Sewerage Board, Newton, Mass.; William E. Whittaker, civil engineer, Metropolitan Water Works, Boston, Mass.; W. Dayton Frederick, commissioner Public Works, Bridgeton, N. J.

Adjourned.

Attest: WILLARD KENT, *Secretary.*

DEXTER BRACKETT.

Past President, New England Water Works Association.
Died August 26, 1915.

Dexter Brackett, as one of the early members of the New England Water Works Association, and at various times Vice-President, President, Senior Editor, Secretary *pro tem.*, and member of the Executive Committee, has an unique place in the history of the Association. Although his face, once so familiar, will no longer reflect his kindly spirit in the meetings, his inspiration, the benefits of his clear foresight, and the results of his efforts to keep the Association on the right road to usefulness, will long continue. As a friend many a member, younger and elder, will long cherish his memory. Some of his earlier *confrères* in the Association thus write of him:

"Dexter Brackett joined our Association in 1885, was made a Vice-President in 1889, President in 1890, a member of the Executive Committee in 1891, and an Editor of our Journal during the years 1892, 1893, 1894, and 1895. He contributed his first paper in 1886, and till his death took a very active interest in the affairs of the Association, contributing greatly to its success by furnishing valuable papers himself and by ably discussing those presented by others. These accomplishments are matters of record; other work of his, unrecorded and not generally known, but as valuable, in my opinion, as any he ever did for the Association, was that performed by him in bringing into our ranks many men eminent in the engineering profession." — *Albert S. Glover.*

"I first became acquainted with Dexter Brackett in the early eighties. A little later (April, 1885) he joined the New England Water Works Association. A personal friendship with the writer then gradually developed that remained undiminished as long as he lived. He first appeared before the Association with a paper concerning water waste, in 1886, after which he frequently contributed to the literature and discussions of the society. He set a high standard and secured many valuable papers for the meet-

ings. I was Secretary of the Association during his term as President, and thus came in frequent contact with him. He was an indefatigable worker for the interests of the Association, and he always produced results. It was a pleasure and satisfaction to work with a man of such convincing ideas. He put a tremendous amount of labor into the work of his administration. There was no lack of inspiration while his hand was at the helm. He was a working president in every sense that the word implies. When I was finally compelled to resign the secretaryship in 1895 he took up my work as Secretary *pro tem.* in addition to his duties as Editor, and continued for a month until a new Secretary was elected. Mr. Brackett possessed a broad outlook, a keen mind, and, above all, a sanity of view that was always helpful to those not so well informed, and he was generous in helping others. He was loyal to the public welfare in an exceptional degree. He possessed a high standard of what was due to the public, and he rendered that service faithfully and competently. What he was to all who knew him a little while ago he will always be to them now, one to mourn because he has gone away, one to remember always with exceeding joy." — *R. C. P. Coggeshall.*

"I remember Mr. Brackett very well when the New England Water Works Association was first formed. He was connected with the distribution system of the Boston Water Works, and naturally took much interest in matters connected with piping plans. He frequently added to the value of papers and discussions by his accurate knowledge and enthusiastic interest. I think he was one of the first to study seriously the growing dangers from waste of water in public supplies, and the literature of this branch of water-works engineering owes much to his investigations. I was associated with him for many years and should like to bear testimony to the constant progress which he made in his professional career. He was indefatigable in the pursuit of knowledge, and continued his work to the very last with but few intermissions." — *Desmond FitzGerald.*

"In the long backward look of something like thirty years, I recall Dexter Brackett as one of the notable men in the early history of the New England Water Works Association. Tall, clean-shaven, rather spare in figure, he was once referred to by some one in Boston who did not know him as that long-legged schoolboy who told you what you could or could not have in the line of water-supply. Youthful he was in appearance, in those early days when he discovered underground leaks in the Boston street mains, by the Deacon method. But his skill, discretion, and clear thinking were not those of the average youngster, and

his ability soon brought the recognition that it so well deserved. Pleasant he was, courteous and kindly, and fortunate were those who worked with, and knew him." — *Wm. R. Billings.*

Dexter Brackett, the only son of Cephas Henry and Louisa Thwing (Pierce) Brackett, was born November 30, 1851, in Newton, Mass. During his childhood, his parents removed to the adjoining town of Brighton, which subsequently became a part of the City of Boston. He was educated in the town schools and graduated from the Brighton High School in 1868. In 1868–1869 he took a six months' course at a business college.

As is the case with many young men, he had no well-defined plan as to his life work, but in March, 1869, age seventeen years, an opportunity was presented for his employment in the city engineer's office, Boston, and as engineering appeared to him a desirable line of work, he accepted the position. The time proved to be a favorable one, as the city engineer's office had been recently reorganized, and the great increase in the territory of the city by the annexation of several towns, one after another, from 1868 to 1874, caused a large increase in the engineering work to be done, with corresponding opportunities for promotion. Only one of the five municipalities annexed was provided with a public water supply, and Mr. Brackett was soon assigned to the work incident to the extension of the pipes into these municipalities and the establishment of a new high-service system of supply. The great fire in Boston in November, 1872, also called urgent attention to the necessity for a more adequate system of main pipes in the city proper.

One of the most noteworthy events in the early part of Mr. Brackett's professional career, as well as in the careers of many of his associates, was the election of Mr. Joseph P. Davis as city engineer of Boston, in the spring of 1873. His personality and the high grade of his professional work molded to a large extent the subsequent careers of those under him. The office served as a most valuable training school, both in engineering and in ethics, a fact which was fully recognized by Mr. Brackett during his life, as well as by many of his associates.

Under Mr. Davis's direction, Mr. Brackett was early placed in charge of the distribution system of the water works. In

addition to the large amount of work done in extending and reinforcing the water-pipe system in those years, the question of the waste of water soon came to the front, on account of the increasing water consumption, and as early as 1878 Mr. Brackett began a study of this problem for Mr. Davis. At that time, although the waste of water was recognized as a very important factor, it was not nearly as large as in subsequent years. Water meters were then much more expensive and less durable than at the present time, so that the remedial measures proposed were in the line of the restriction of waste through its detection by inspection, aided by the use of Deacon meters. Church stopcocks and Bell waterphones were also tried as aids in this work. In the next few years, Deacon meters were set in some districts of the city, and a very marked reduction in the consumption and waste of water resulted. Thus Mr. Brackett became especially interested in the consumption and waste of water, and an authority upon the subject. In addition to material prepared for the official city reports, he presented a paper on the subject to the New England Water Works Association in 1886 and to the American Society of Civil Engineers in 1895.

During Mr. Brackett's long connection with the Boston Water Works, which continued until August 1, 1895, he had experience with every phase of water distribution. His work included not only engineering, but duties as superintendent in direct charge of the constructing and operating forces, from February, 1888, to June, 1891, and covered such features as the laying of pipes across navigable streams, the raising of large mains while full of water, the cleaning of tuberculated pipes, the testing of fire engines and fire boats, the construction of a high-pressure system of piping for fire protection only, the installation and testing of heavy pumping machinery, and the construction of distributing reservoirs.

In 1895, he was asked by the State Board of Health of Massachusetts to advise as to the present and future consumption of water per inhabitant in the Metropolitan Water District, and made a valuable report.* His predictions made in 1894 as to the

* Special Report, State Board of Health of Massachusetts, on a Metropolitan Water Supply, 1895, page 157.

probable water consumption per inhabitant thirty years later now seem likely to be verified. In 1904 he made a very complete report to the Metropolitan Water and Sewerage Board,* on the measurement, consumption, and waste of water supplied to the Metropolitan Water District, which was transmitted to the state legislature as a basis for action in regard to the restriction of waste.

On August 1, 1895, the engineering force of the Metropolitan Water Works was organized, and Mr. Brackett, on account of his preëminent qualifications for the place, was selected as engineer of the Distribution Department, in charge of the construction of the pipe lines, pumping stations, and reservoirs in the Metropolitan Water District. The essential parts of the works were planned and executed rapidly and well, and had advanced far enough by January 1, 1898, the date fixed in the legislative act, to permit the water to be conveyed to all parts of the district. The pumping stations constructed and maintained for many years under this direction are regarded by many who have visited them as models in respect to economy and efficiency.

On February 1, 1907, Mr. Brackett became chief engineer of the Metropolitan Water Works, and held this position to the time of his death. In this capacity his duties related largely to the maintenance and operation of systems already constructed, a kind of work which he enjoyed. He was very successful in selecting his assistants in charge of the various portions of the works, and under his supervision an extremely efficient and loyal force was developed. There were, however, during this time important additions to the works, among which may be particularly mentioned the hydro-electric plant at the Wachusett Dam in Clinton; the forty-million-gallon high-service pumping engine at Chestnut Hill; the sixty-inch cast-iron pipe line from Weston to Chestnut Hill Reservoir, including the pressure tunnel through a hill in Newton; the improvement of the water supply for the elevated districts in Boston, Hyde Park, and Milton, including the pumping station at Hyde Park and the steel tank on Bellevue Hill one hundred feet in diameter and forty-five feet high, surrounded by a

* Annual Report, Metropolitan Water and Sewerage Board, January 1, 1904, page 301. Also Journal N. E. W. W. Association, 1904, Vol. XVIII, page 107.

masonry tower; and the hydro-electric plant at the Sudbury Dam in Southboro now in process of construction.

One important reform has taken place on the Metropolitan Water Works since he became chief engineer, namely, the introduction of water meters. This resulted largely from reports written by him upon the subject of consumption and waste of water, and from his persistent advocacy of the use of meters within the Metropolitan Water District as a means of reducing waste. He had the privilege of seeing his views adopted and the consumption of water thereby greatly decreased. Up to 1907, the consumption had been increasing so rapidly as to point out the necessity for an additional supply within the next few years, but the gradual introduction of meters reduced the consumption so rapidly that no additional supply will be needed for many years, the consumption now being less than two thirds of what it would have been had the former rate of increase continued.

In addition to his regular engineering work, Mr. Brackett was called as an expert in connection with water supplies at Fall River, Stoughton, Taunton, New Bedford, Ashburnham, and Springfield, Mass.; Auburn, Me.; Syracuse, N. Y.; Atlantic City, N. J.; Louisville, Ky.; Springfield, Mo.; Harbor Springs, Mich.; and other places, in several cases in connection with the testing of pumping engines or the valuation of the works. He ceased to accept the many engagements offered him along these lines after 1895, at first because the Metropolitan Water Works demanded all of his time, and later because a diminishing vitality made it undesirable for him to accept the burden of work in addition to that required by his regular duties.

In all, Mr. Brackett served the City of Boston and the Metropolitan Water District for forty-six years, most of the time in positions of much responsibility. Taking into account his entire trustworthiness and loyalty to his work, and his special ability in the branches of water-works engineering in which he was engaged, it is difficult to over-estimate the value of the public service which he rendered during his long professional career.

Mr. Brackett was a director of the American Society of Civil Engineers, 1908–1910; president of the Boston Society of Civil Engineers, 1897–1898; president of the New England Water Works

Association, 1889–1890; and a member of the American Water Works Association and the Boston City Club.

Some of the more important papers contributed by him to the technical societies, in addition to those on the subject of the consumption and waste of water already referred to, related to the raising or otherwise moving of large water mains, the consumption of water at a large fire in Boston on November 28, 1889, the tuberculation of water pipes, the freezing of fresh water in a pipe submerged in salt water, and a description of the Metropolitan Water Works, presented to the American Water Works Association. He was an important member of the committee of the New England Water Works Association which prepared standard specifications and drawings for cast-iron water pipes and special castings. The specifications and plans were adopted by the Association on September 10, 1902.

On September 21, 1875, Mr. Brackett married Miss Josephine Dame, who survives him. He also leaves one son.

Mr. Brackett was elected a member of the New England Water Works Association April 21, 1885; was a Vice-President, 1888–89; President, 1889–90; and Senior Editor, 1891–95.

Frederic P. Stearns,
Alfred D. Flinn,
Allen Hazen,
Committee.